ADOPTION OF PERFORMANCE MEASURES IN REGIONAL TRANSPORTATION PLANNING: CURRENT PRACTICE AND LESSONS FOR FUTURE APPLICATIONS

A Dissertation
Presented to
The Academic Faculty

by

Alice Grossman

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy in the
School of Civil and Environmental Engineering

Georgia Institute of Technology
May 2018

ADOPTION OF PERFORMANCE MEASURES IN REGIONAL TRANSPORTATION PLANNING: CURRENT PRACTICE AND LESSONS FOR FUTURE APPLICATIONS

Approved by:

Dr. Randall Guensler, Advisor
School of Civil Engineering
Georgia Institute of Technology

Dr. Kari Watkins
School of Civil Engineering
Georgia Institute of Technology

Dr. Catherine Ross
School of City and Regional Planning
Georgia Institute of Technology

Dr. Michael Meyer
Senior Advisor
WSP

Dr. Joshua Schank
Chief Innovation Officer
LA Metro

Date Approved: January 12, 2018

ACKNOWLEDGEMENTS

Thank you to all of the university faculty, students, and researchers who have supported, encouraged, and challenged me at Vassar College, the Georgia Institute of Technology, and elsewhere; especially to my committee members, Randall Guensler, Catherine Ross, Michael Meyer, Kari Watkins, and Joshua Schank whose patience and feedback have been invaluable. I appreciate all the time and dedication from Robert Simon, and thank you to Jim Mullholland, Reginald DesRoches, and Larry Jacobs for upholding an outstanding Civil and Environmental Engineering Department and for supporting my own personal education and well-being. I especially appreciate all of the lunch hours Michael Meyer has spent meeting with me that have helped formulate ideas and move my research forward.

This research would not have been possible without survey pre-testing and feedback from Giovanni Circella, Kermit Wies, and Regan Hammond, or the generous time of the MPO staff at ARC, BMC, KIPDA, and BMC who allowed me to interview them.

And, of course, thank you to my family, Sarah, Ben, Lindsay, Rachel, Simon, Hannah, Giovanni, Adam, and Mike.

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LIST OF SYMBOLS AND ABBREVIATIONS

MPO	Metropolitan Planning Organization
DOT	Department of Transportation
USDOT	United States Department of Transportation
MAP-21	Moving Ahead for Progress in the Twenty-First Century
TEA-21	Transportation Equity Act for the 21st Century
ISTEA	Intermodal Surface Transportation Efficiency Act
SAFETEA-LU	Transportation Equity Act: A Legacy for Users
FAST	Fixing America's Surface Transportation
LRTP	Long-Range Transportation Plan
RTP	Regional Transportation Plan
TIP	Transportation Improvement Program
MTP	Metropolitan Transportation Plan
STIP	Statewide Transportation Plan
HPMS	Highway Performance Monitoring System
NTD	National Transit Database
NHS	National Highway System
SOV	Single Occupancy Vehicle
CMAQ	Congestion Mitigation and Air Quality
NAAQS	National Ambient Air Quality Standards
CAA	Clean Air Act Amendments
TRB	Transportation Research Board
AASHTO	American Association of State Highway and Transportation Officials

FHWA Federal Highway Administration

BPC Bipartisan Policy Center

SUMMARY

Performance measures play an important role in transportation planning, project prioritization and decision-making. Metropolitan Planning Organizations (MPOs) have been tasked by the Moving Ahead for Progress in the 21st Century (MAP-21) federal transportation legislation to develop short- and long-term transportation plans that include performance measures. Measures required by legislation are standard, uniform indicators for specific projects and entire metropolitan regions, and lead to MPOs implementing performance analysis serving as evidence of the productive use of taxpayer dollars and providing public accountability. Agencies are in the process of responding to federal rulemaking in implementing and incorporating the required safety, infrastructure, congestion, system reliability, freight, and environmental performance measures.

This dissertation research includes a nationwide survey and four urban transportation planning case studies. A survey response of 183 (45%) of the 405 MPOs across the country reveals when agencies began collecting federally mandated performance measures as well as additional non-mandated measures, how performance measures link to regional and state goals and priorities, what factors currently may impede agencies from adopting performance-based planning practices, and where agencies appear to be looking for examples, best practices, and data sharing. Only 12 out of the 183 responding agencies reported using all of the federally required measures. Larger MPOs are generally adopting more measures and introducing them earlier, and agencies located in the Northeast and Western states (where many of the larger regions are located) are generally ahead of regions in the South in implementing performance-based planning. Medium-sized MPOs show no

discernible trend in responding to the federal requirements and have not adopted as many additional non-federally mandated performance measures as larger MPOs. Many agencies reported a lack of resources – both monetary and in personnel – contributing to their inability to quickly and efficiently adopt new data-driven practices.

Four case studies provide examples of best practices. Case studies reveal the varying levels of coordination between MPOs and state DOTs. Agencies demonstrating best practices in incorporating performance-based planning into their long-range plans in recent years are only now including the methods in short-term Transportation Improvement Programs (TIPs). The survey results and case studies provide the most comprehensive data and research to date of MPO response to the MAP-21 performance measure mandates indicating state of the practice across the country and present best practice models.

CHAPTER 1. INTRODUCTION

Metropolitan Planning Organizations (MPOs) have been tasked by federal legislation to develop short and long-term transportation plans that include performance measures. Depending on how they are used, these performance metrics play an important role in transportation project prioritization and decision-making. This research tackles the questions of how performance measures are developed and used by examining regional transportation policy development both within the regional and state context and as it relates to federal legislative requirements. The study looks at how MPOs across the country, 1) use and develop standard and unique performance measures; 2) adopt performance-based planning practices in conjunction with federal legislation; 3) face barriers to using performance measures; 4) prioritize and evaluate projects; and 5) act on the influence from local, state, and federal goals, regulations, and legislation in their use of performance measures. A survey of all MPOs in the country and select case study analyses guides the research to compare and contrast how MPOs of different sizes, political climates, geographic locations, and other defining features elect to measure performance and apply those numbers to project selection, prioritization, and evaluation. Additionally, best practices are presented from regional agencies of varying size, geography, and geopolitical structure.

The objectives of the survey analysis include creating snapshots of the current national state of the practice in performance-based planning at MPOs and the barriers that agencies face, as well as creating grouping of agencies to direct staff looking for examples and best practices towards peer agencies that might be in a similar current situation or face

the same barriers. The case studies serve to dive deeper into the process and outcomes of diverse types of MPOs.

Examining agency planning practices alongside national goals and requirements can provide insight into how federal legislation is affecting regional transportation systems. The national snapshot from survey responses along with the in-depth analyses of various urban regions provided in this dissertation will help planners, engineers, and policy makers further understand the current state of the practice in performance-based transportation planning as well as the relationship between federal, state, and regional level agencies within the context of recent policies.

Understanding the regional impacts of federal legislation is necessary to effectively create and interpret future transportation legislation. Although transportation policy, planning, and design can be traced back to the nation's founding, modern surface transportation legislation began in the 1960s with the creation of the Interstate system, and evolved over time with the USDOT created shortly after to assume regulatory duties. Today, Fixing America's Surface Transportation (FAST) Act is in place and perceptions and best practices for federal oversight and regulation have changed dramatically. An understanding the relationship between legislation and implementation at a regional, urban scale, can inform any future transportation policy-making.

This dissertation utilizes dual module research design approach of a survey and case studies, and includes the development of a general framework to contextualize the research elements. The background section covers a brief history of surface transportation legislation and the current laws and regulations. It also includes legislation and policy

relating to performance in fields beyond transportation. The survey and case study chapters each open with a brief literature review of relevant recent studies of similar topics and structure. The survey chapter includes descriptive statistics of the responding agencies and their practice in performance-based planning, as well as crosstabs analysis, variable correlation assessment, regression modeling, and cluster analysis. The four cases study MPOs include the Atlanta Regional Commission (Atlanta, GA), the Baltimore Transportation Study (Baltimore, MD), the Bannock Transportation Planning Organization (Pocatello, ID), and the Kentuckiana Regional Planning and Development Agency (Louisville, KY). The case studies review agency planning and project prioritization documents and methodologies, state DOT documents, and include interviews with staff in charge of performance management at each agency. The conclusions take engineering, planning, and policy findings into account to provide recommendations useful to regional, state, and federal agencies.

CHAPTER 2. RESEARCH DESIGN

This work is divided in two data collection and analysis modules: 1) a comprehensive national survey to MPOs; and 2) case studies identifying examples and best practices across various types of regions. The two-part study is further informed by literature review and background information and followed by planning, policy and engineering recommendations that flow from the findings. Previous studies have shown that a two-part research approach survey and case study analysis in the context of transportation performance or planning policy changes can produce broadly and specifically useful results and each element acts as a support to findings from the other (Faga, 2014, FDOT 2014, Bond, 2010). Figure 1 shows the study design from literature review, to survey, to case studies, to synthesis and recommendations.

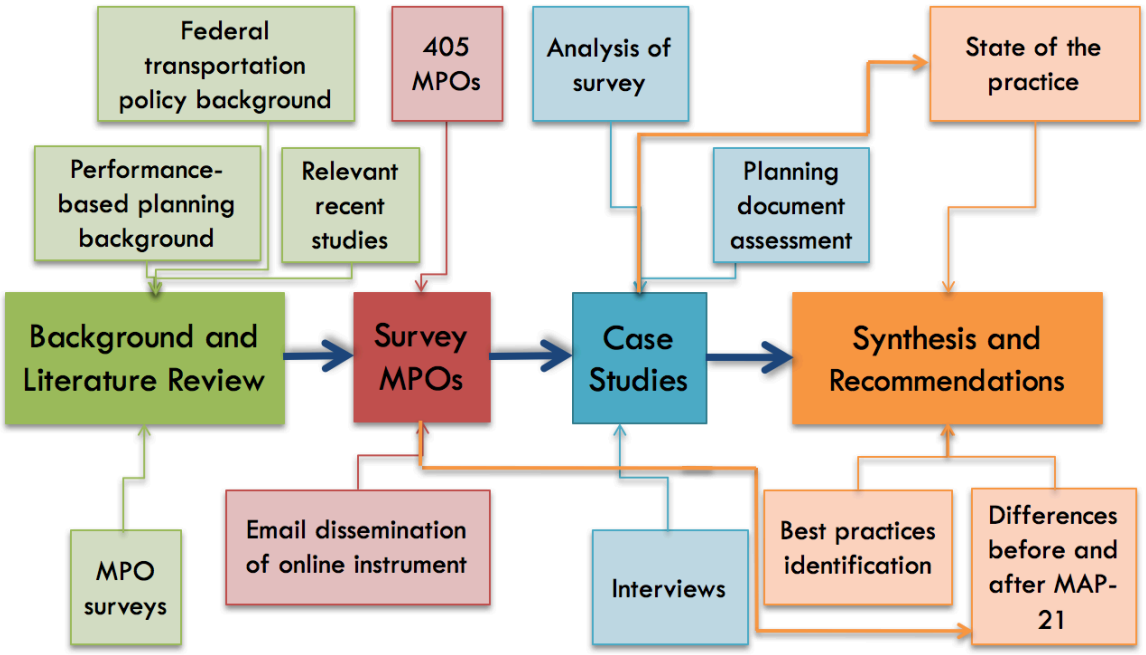


Figure 1 - Research Design

Literature review on previous and current transportation legislation as well as scholarly work analyzing performance-based planning and changes in the planning process around policy changes gives background and context to MAP-21 and the FAST Act. Understanding the evolution of federal law-making puts current policies into necessary context. The introduction of new elements into legislation is often a gradual process, and given that MAP-21 marks the first law that requires performance-based planning from states and MPOs it is best looked at as a beginning. Just as the Intermodal Surface Transportation Efficiency Act (ISTEA) was transformative surface transportation legislation that led to many later bills, future acts will build upon MAP-21.

Previous studies and surveys informed the design and analysis of results for the survey to MPOs on performance-based planning before and after MAP-21. Literature review on survey development, deployment, and analysis for other surveys deployed to

MPOs or other similar agencies informed content development and expected response rates. While previous surveys typically group MPOs by size only, more extensive analysis is undertaken in this study using cluster analysis inform the best grouping of regions to look at best practices.

Survey results helped to inform case study selection. Regions chosen for case study analysis fall under different size categories, geographical locations, governance structures, and types and timing for performance measures use. The studies include in-depth analysis of performance-based planning, specifically looking at processes and measures and when the agency began using them. Relationships with state DOTs, transit agencies, and other relevant agencies reveal potential for collaboration that can enhance data sharing and inform planning and policy. The case studies were conducted by phone and in person for the regions of Baltimore, MD (Baltimore Regional Transportation Board); Atlanta, GA (Atlanta Regional Commission); Louisville, KY (Kentuckiana Regional Planning and Development Agency); and Pocatello, ID (Bannock Transportation Planning Organization).

Figure 2 shows a conceptual framework relating data; metrics; and real-world systems, agencies, stakeholders, and documents to transportation plans.

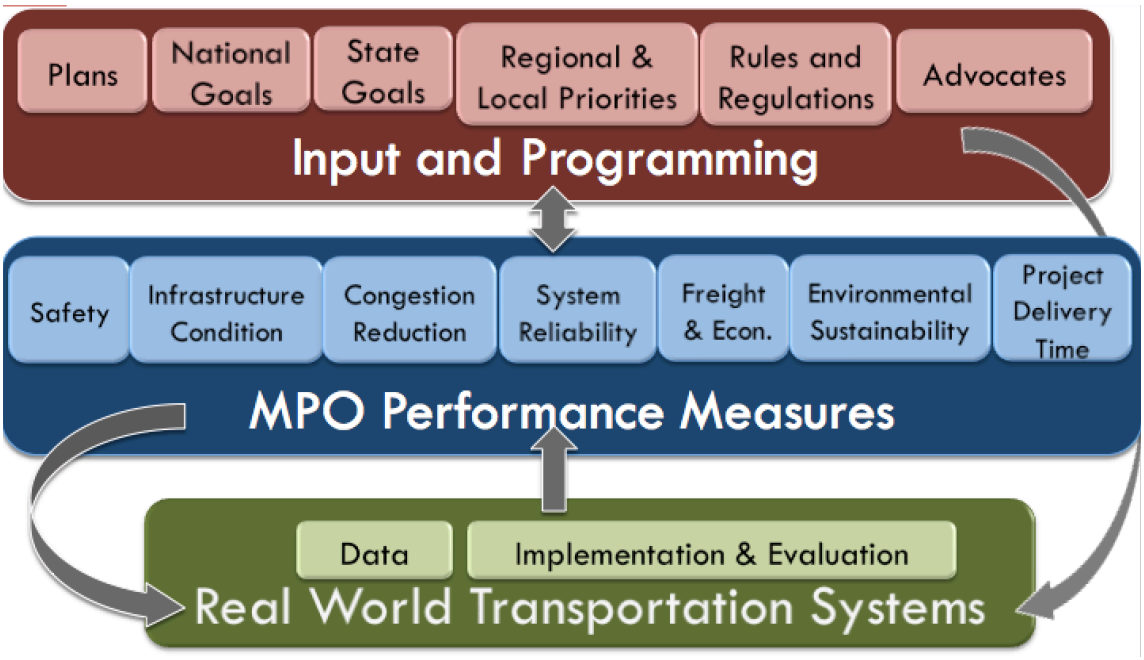


Figure 2 - General Performance-Based Planning Framework

Obtaining and managing data and using those data to inform decision-making is a necessary starting point for all agencies to establish when delving into performance-based planning. The performance measures that the regional and state agencies decide on, which will eventually include all of those required by MAP-21 (as listed in diagram), as well as possible additional categories, are only measurable with data and asset manage systems already in place. Evaluating performance includes setting targets and working towards meeting those targets within a specified time frame. MPOs and State DOTs can thus incorporate these performance-based methods into planning and policy documents such as the long-range transportation plans, TIPs, and STIPs. The data agencies choose to collect often tie into local, region, state, or national goals and priorities, as agencies can than track their progress towards stated goals through performance measure target meeting. Federal regulations require certain measures and target setting, and state laws and policies further influence transportation planning and programming at a regional level. Public engagement

is mandatory to inform planning and project development, but additional input from communities and advocacy groups often further influences decision-making for local and regional transportation. Public input and changes to regional plans then affect what projects get implemented and how data and targets are collected and set moving forward.

Survey data reveals data availability in the real-world transportation systems, as well as measures used and the relationship with state and local goals and priorities. Review of federal, state, and regional plans, rules and regulations further inform the relationship between input and programming and the use of performance measures by regional agencies. Each case study relates back to this base framework for the relationships between policy, planning, and real-world systems, and adapts it in specific detail for the region in question.

CHAPTER 3. TRANSPORTATION POLICY AND PLANNING BACKGROUND

Since the Federal Aid Highway Act of 1956, and the establishment of a United States Department of Transportation (USDOT) in 1966, legislation and regulations for transportation planning in the U.S. have continued to evolve. While other executive Departments such as the departments of Health and Education have a longer history of tying quantitative evaluation to federal funding, congress has only tasked the USDOT with developing regulations including performance measures in the last half decade.

Nationally coordinated asset and condition data reporting was not new to transportation in 2012 when Moving Ahead for Progress in the 21st Century (MAP-21) was passed. FHWA established the Highway Performance Monitoring System (HPMS) in 1978, the National Transit Database (NTD) reports date back to 1997, and the first Annual Benchmarking Report from the Alliance For Biking and Walking came out in 2010. However, the performance measurement and evaluation through target setting and reporting makes MAP-21 requirements an important step forward in the types of data-driven planning expected from transportation agencies. Meanwhile, many fields have turned to uniform performance reporting for much longer, and there are lessons that can be learned when one looks beyond the field of Transportation.

3.1 Performance Measurement Across Diverse Fields

Health, Public Safety, and Education all have a history of performance-driven decision-making and federal funds tied to performance data collection and reporting. The

policies and funding decisions have a large impact on public health, education levels, and public spending. In 2015 congress allocated six percent of discretionary spending on health, and six percent on education, compared to two percent on transportation (National Priorities Project, n.d.).

In their *Performance Measures for Healthcare Systems*, Nerenz and Neil (2001) note that even though data collection and performance monitoring have been used at hospitals since at least the 19th century, many institutions recoiled at attempts to make data collection and reporting mandatory in the 1990s (Nerenz and Neil, 2001). Many databases ended up providing a list of approved measures that hospitals could opt into, as long as they report enough measures, they could report whichever ones they chose. A system more similar to this could be beneficial to our transportation agencies, many of whom are already collecting data for performance monitoring which could be just as useful as (if not more than) USDOT list of measures. Requiring a certain number of measures within each performance area could further provide a balance monitoring across the system with many comparable measures but less undue burden on the agencies.

In general, public safety policy is set more at a local and state level than federal. Just as some question the constitutionality of Federal control over health care in the United States, criminal justice, law enforcement, and emergency response, among other aspects of public safety have largely been left to local, regional, and state legislators. However, researchers have recognized the need to be able to compare performance across city, county, and state lines, as well as the benefits to linking performance measures to national goals (Bach, 2010; DeIulio, 1993). The independent, non-profit, non-governmental organization, Pew Charitable Trusts, has founded an entire project called the Public Safety

Performance Project to assist states in using performance management techniques to establish more efficient public safety practices (Pew Charitable Trusts, 2017).

Texas is one example of a state that implemented major policy changes related to criminal justice in the first half of the twenty-first century. The state set goals to reduce incarceration, crime, and public spending on correctional costs. In 2005 new legislation introduced incentive-based initiatives for police departments to work towards certain goals. In 2007 and 2009 further adjustments to the legislation were added, and assessments showed that fewer people were being incarcerated and the state was saving money "SB 1055 allowed counties to enroll in performance incentive funding if they met certain requirements such as reducing prison populations, reducing recidivism, increasing the amount of probationers making victim restitution, and increasing probationers' employment rates" tying incentive funding to goals seemed to work for Texas in reaching their previously stated goals (Glod, 2015).

One of the largest recent attempts by Congress to require targets and performance measures was the 2001 Education Act, No Child Left Behind. The bill included nationally uniform measures and targets for public schools to meet across different categories such as reading, math, and science (PL 107-110). The mandated targets were seen as especially inequitable and unproductive. Attempting to standardize the education system across all regions and states in one act was clearly ineffective. As Education Psychologist Robert Linn noted in 2002, "If requirements in the NCLB law were taken at face value and current state tests and performance were used as starting points, it is clear that the requirements would vary greatly in stringency across states. It also is clear that states with reasonably

ambitious tests and performance standards would have unobtainable AYP objectives." (Linn et al., 2002).

In 2015, Congress replaced the No Child Left Behind Act with a more states-oriented law. The newer, bi-partisan Every Student Succeeds Act eliminated Federal government consequences for not meeting specific performance targets and leaves target setting and poor performance consequences up to the state. The Every Student Succeeds Act passed overwhelmingly in the House and allows each district to set their own metrics (PL 114-95).

In this way, it seems that the USDOT may have learned from the education sector. By allowing states to set their own targets and not penalizing agencies for a subjectively non-contextual "low" performance, the federal government is requiring states and urban regions to incorporate performance-based planning without a potential detriment to the overall system as occurred in many public schools post 2001. The continued requirements to report data can help law-makers, educators, and the general public track changes in public school student performance and base funding and programing decisions off of a data-driven approach. One aspect of the education performance tracking that is not visible in MAP-21 or the FAST Act is the requirement to identify the lowest performing areas of the system (i.e. lowest performing schools), which could help MPOs, states, and the USDOT think about where to allocate funds (PL 114-95).

Just as MAP-21 was not the final word on what future performance requirements will be for transportation agencies, neither was the Every Child Succeeds Act, and much further and useful critique can be found across the fields of education and public policy.

One major difference to keep in mind (of course, there are many), is that K-12 public education has included mechanisms for quantitatively assessing students at a local/school level through exams, graduation rates, etc., and the great breadth of educational theories over hundreds of years suggest different types of assessment as way to measure success. Meanwhile, MAP-21 led many transportation agencies to begin incorporating performance measurement, even just for internal evaluation, for the first time and transportation engineering has a much more uniform definition of acceptable and successful performance.

3.2 Transportation Legal and Policy Framework under the US Constitution

The founding fathers of United States of America created a union of states governed by a federalist system with strong states' rights. Given that the power of the Federal Government is limited by what is specified in the Constitution, legislation relating to transportation must be incorporated within the constitutionally-granted areas of oversight of collecting taxes and spending of federal taxes; managing the use of public land; regulating interstate commerce; national defense; etc.

Transportation legislation is written by Congress and bound by the powers granted to congress by the US Constitution. The executive branch agencies, which in the case of transportation legislation is the United States Department of Transportation (USDOT) is then tasked with interpreting the laws into written regulations, and the judicial branch will uphold a legal decision if/when a case is brought to them. Figure 3 shows the roles of and interactions between the three branches of government and the public in the regulatory process.

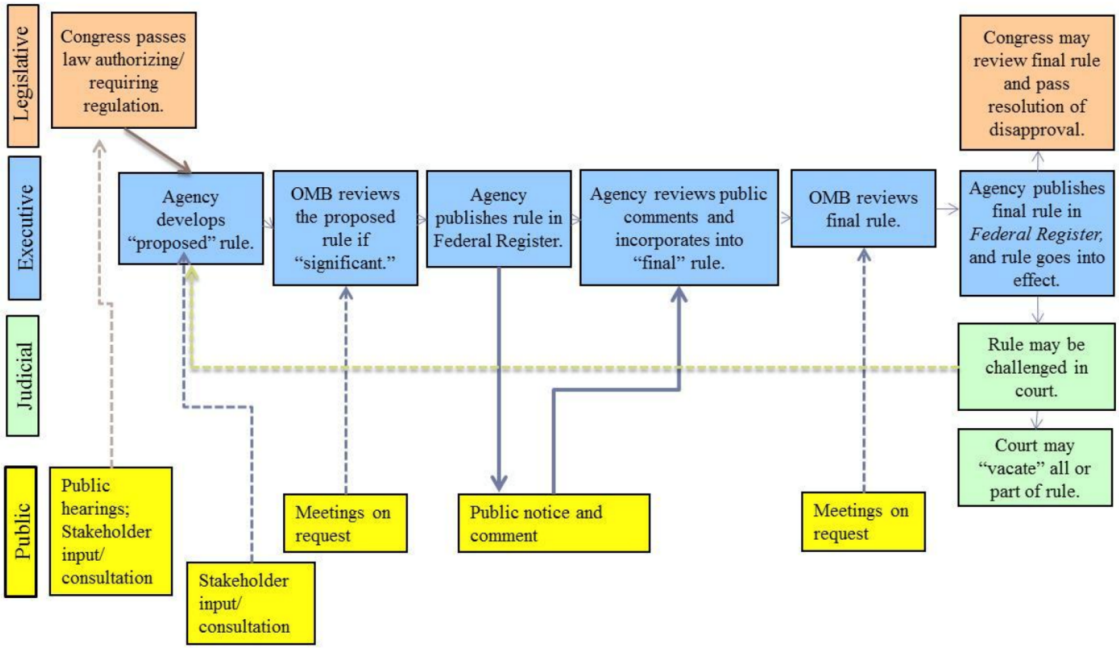


Figure 3 - Federal Regulatory Process

(Source: Balla and Dudley, 2014)

Thus, both congress in the writing of the bill and the USDOT in forming regulatory requirements work within boundaries and incorporate public input to guide national transportation policy, mostly relaying on tying state and regional requirements to federal funding so as not to overstep their constitutional authorities.

Furthermore, each state has their own state constitution, some of which are more prescriptive than others. State Departments of Transportation (DOTs) also have statewide transportation plans as well as other planning and policy guides. State DOTs and Metropolitan Planning Organizations (MPOs) must therefore be mindful of state laws and plans on top of fulfilling federal requirements.

3.3 History of Modern Federal Surface Transportation Legislation and Regulation

The acknowledgement of the need for comprehensive transportation planning in urban regions of 50,000 or more people dates back to the Federal Highway Act of 1962. However, MPOs were not tied to the receipt of federal funding until 1973 (PL 87-866; PL 93-87). In 1991, congress passed the first intermodal transportation surface bill, ISTEA, under President George H.W. Bush. The history of federal transportation policy led to current practice, which will in turn inform the future of our nation's transportation laws and practices. Figure 4 shows a timeline of the surface transportation acts since then leading up to Moving Ahead for Progress in the 21st Century (MAP-21), and the FAST Act.

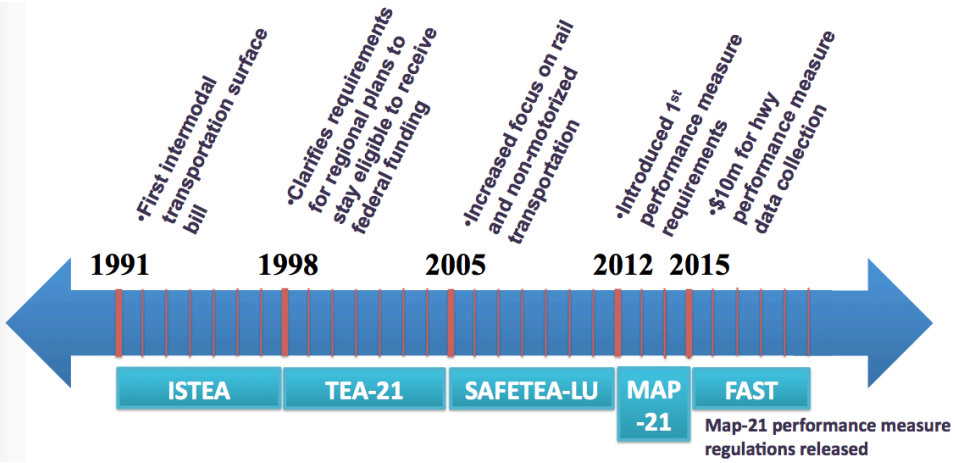


Figure 4 - Federal Legislation Timeline

ISTEA was seen as the first major post-interstate transportation act. Congress focused on their right under the US constitution to regulate commerce and set the goals of ISTEA as relating to economic competitiveness while maintaining environmental efficiency and safety. The Act instated the National Highway System (NHS), doubled the

MPO budgets for transportation, making them a vital agency in urban transportation planning. Many special programs for funding state DOTs and MPOs began under ISTEA, such as the Congestion Mitigation and Air Quality (CMAQ) Improvement Program and the Transportation Improvement Program (TIP) that requires short-term planning and fiscal constraint to project lists (Weingroff, 2001; PL 103-240).

ISTEA linked to the Clean Air Act Amendments (CAAA) of 1990, which set requirements for states and urbanized areas to track air quality and reach a certain attainment level for specified particulate matter. These National Ambient Air Quality Standards (NAAQS) must be included in a state implementation plan, and attainment in urban areas is tied to federal funding for that area. Similar to the performance measure requirements in MAP-21, CAAA required additional data collection and monitoring by regions without providing formula funding to adopt and carry out a monitoring system. There were, however, CMAQ grants created that provided $1 million a year nationally for projects related to achieving NAAQSs (Weingroff, 2001; Davis, 2016).

Receiving funding to carry our surface transportation planning and projects gave urban areas a big step-up in advancing their intermodal transportation systems. In a 2003 Brookings report, Bruce Katz et al. state that ISTEA and the Transportation Equity Act for the 21st Century T(EA-21) "gave states and metropolitan areas the certainty in funding and the flexibility in program design necessary to attempt new transportation solutions." The authors argue that the money and flexibility allowed agencies to balance new projects and maintenance as well as road and transit projects. The transportation acts from the 1990s also created the Bureau of Transportation Statistics, which enhances transparency in public

spending and decision-making to the public through data reporting (PL 105-178, Katz et al., 2003).

The authors hoped to gain insight looking ahead to the next transportation authorization which passed in 2005 entitled Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) by looking back at previous bills and state and MPO reactions to them. Katz et al. argue that the purpose of giving MPOs more authority under TEA-21 was not met, and many states maintained excessive control over metropolitan regions. They also suggest uniform performance measures.

Moving into the twenty-first century, leaders in the field of transportation generally agreed that performance based planning was the next step in federal requirements (Meyer, 1991). The Transportation Research Board (TRB), along with many State DOTs, MPOs, and other governing transportation agencies began researching, discussing, and implementing performance-based planning in the late twentieth century (TRB, 2001). Connections to previous legislation are particularly notable from SAFETEA-LU, which established The National Surface Transportation Infrastructure Financing Commission to assess future surface transportation needs. The Commission pointed towards the need to measure performance to properly assess the use of funds. Their February 2008 interim report foresaw and recommended the use of performance objectives, "performance-based approaches to investment have not received the emphasis that will be necessary for the future" (National Surface Transportation Infrastructure Financing Commission, 2008).

By 2012 when congress enacted MAP-21 legislation but no official recommendations for performance measures had made it out of the USDOT yet, many interest groups had already begun speculating and influencing the legislation content and the regulations to come. Associations such as The American Association of State Highway Transportation Officials (AASHTO) began suggesting performance areas from which some state DOTs and MPOs began/continued forming performance based plans. (AASHTO, 2012). The Bipartisan Policy Center (BPC) and the Eno Center for Transportation (Eno) recommended through the National Transportation Project that Congress commit to a performance-based approach to strive to reach national goals and to improve accountability of federal spending. The 2012 BPC and Eno report, The Consequences of Reduced Federal Transportation Investment, included specific goals areas to tie to performance measurement and noted the lack of attention paid to monitoring environmental goals (BPC and Eno, 2012). Even back in 2007, SAFETEA-LU required policy and revenue report, Transportation for Tomorrow, recommended environmental measures as well as the other MAP-21 performance measures of travel time reliability, congestion mitigation, safety, multimodalism, and the additional area that did not make it into the law of mobility options for underserved populations (National Surface Transportation Policy and Revenue Study Commission, 2007). Transportation for Tomorrow also noted the need to link measures to goals and relate them to specific funding sources to be able to assess the performance of funding programs. The passing of federal legislation MAP-21 marked the first federal requirements for MPOs to use quantitative measures in transportation planning, and the 2015 FAST Act maintained the same requirements.

3.4 Current Legislation: FAST Act

On December 1, 2015, Congress passed the Fixing America's Surface Transportation (FAST) Act, which is the first long-term surface transportation bill since SAFETEA-LU in 2005. The five-year, funded bill covers roads and bridges, public transit, and passenger rail among other areas, and includes a performance based planning approach carried on from MAP-21. The act gives congress one year to develop performance measures to be able to measure and assess goals in the FAST Act in relation to:

- Environmental regulation under NEPA relating to collaboration
- Projects submitted for improved mobility for people with disabilities must include performance measures to quantify outcomes
- Job and wage outcomes in programs to improve the transportation workforce

The FAST did not significantly further legislative goals or requirements in the area of performance-based planning after MAP-21. The USDOT did not even finish developing rulemaking for MAP-21 performance-based planning requirements until 2017, long after the enactment of the FAST Act. The FAST Act retains many of the same goals as MAP-21. Figure 5 shows the factors that the FAST Act requires for incorporation in MPOs' long range transportation plans (RTPs).

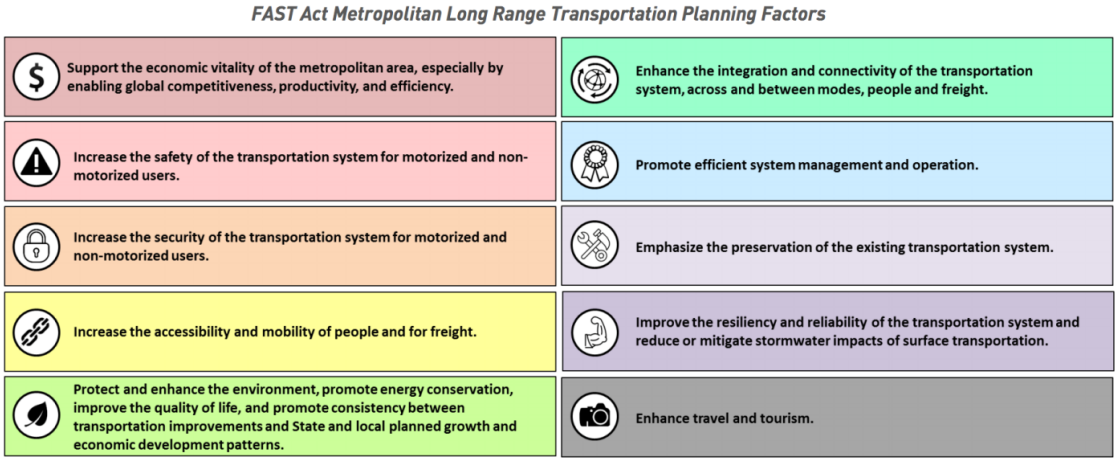


Figure 5 - FAST Act Metropolitan Long-Range Transportation Planning Factors

Source: ARC, 2017

Not all of the factors required for RTPs by the FAST Act are reflected in the current performance requirements, but they may be an indication of future requirements if similar elements continue to be important to congress in long range transportation planning.

3.5 MAP-21

Tracking quantifiable performance measures can help maintain accountability and transparency while measuring effectiveness of individual projects and policies. The FHWA's stated position is that required performance measures will help guide states to work towards national goals in transportation. The agency's MAP-21 Fact Sheet leads off, "The objective of this performance- and outcome-based program is for States to invest resources in projects that collectively will make progress toward the achievement of the national goals." (FHWA, 2013).

However, the performance measure requirements don't actually match up directly with the national goals. Mazmanian and Sabatier suggest in *Implementation and Public Policy* that this is common and it falls on researchers to examine impacts of a policy beyond the stated goals. Programs should be evaluated on how well they meet the legal and stated objectives, but also on any other intended or unintended outcomes (Mazmanian and Sabatier, 1983).

Up through 2016 the USDOT has been developing rulemaking to specify metrics within the areas specified under MAP-21. The seven goal areas listed in the 2012 legislation include:

1. Safety
2. Infrastructure condition
3. Congestion reduction
4. System reliability
5. Freight movement and economic vitality
6. Environmental sustainability
7. Reduced project delivery delays

With specific areas for performance measures identified. MAP-21 requires specific "standard, uniform indicators for projects and metropolitan regions," under each of the following performance areas, however the legislation does not identify each specific measure or indicator. The performance areas are (PL 112-141):

- Pavement condition on Interstate and National Highway Systems
- Performance of the Interstate and National Highway Systems
- Bridge condition on the National Highway System
- Fatalities and Serious Injuries on all public roads
- On-road mobile source emissions
- Freight movement on the Interstate System

The specific measures required fit well into the performance areas listed by FHWA, even though these performance areas don't exactly line up with the seven stated goals of MAP-21. The general purpose of the bill is directly written by congress as (PL 112-141):

> "*(1) to provide support for the condition and performance of the National Highway System;*
>
> *(2) to provide support for the construction of new facilities on the National Highway System; and*
>
> *(3) to ensure that investments of Federal-aid funds in highway construction are directed to support progress toward the achievement of performance targets established in an asset management plan of a State for the National Highway System."*

The first stated purpose seems to be addressed with performance areas in condition, travel time, and delay on roadways and bridges. The second area is less directly related to performance reporting, but understanding the impacts of previous investment through uniform measures is likely to provide support for future projects that will have desired outcomes. The third purpose area of the Bill speaks directly to the use of performance measures and targets towards establish accountability and improving asset management.

3.5.1 Rulemaking under the USDOT

The multifurcation of the law into multiple rules allowed the USDOT to release some measures earlier as the scope for the rule was limited, but prolonged the process of

finalizing the later rules as each notice of proposed rulemaking underwent a public comment period and revisions. Safety measures were seen as both high priority, and easier for agencies to adopt as many states and regions were already accustomed to collecting fatality and other crash data. Table 1 shows the timelines for proposed and final rulemaking by performance area.

Table 1 - Rulemaking Timeline by Performance Area (USDOT, 2017)

Performance Areas	NPRM	Final Rule
Safety Performance Measures	March 11, 2014	Published March 16, 2016
Highway Safety Improvement Program	March 28, 2014	Published March 16, 2016
Statewide and Metro Planning; Non-Metro Planning	June 2, 2014	Published May 27, 2016
Pavement and Bridge Condition Measures	January 5, 2015	Published January 18, 2017
Highway Asset Management Plan	February 20, 2015	Published October 24, 2016
System Performance Measures	April 22, 2016	Published January 18, 2017

The regulations require that states work with MPOs to set targets for each of the required measures within a year of the final rulemaking. MPOs must also set targets for the urbanized area under their jurisdiction with 180 days after the state sets targets. There are no requirements for target values and states and MPOs are expected to work together to the maximum extent possible in developing targets (USDOT, 2015). As part of the plan

in place to hold MPOs accountable for the requirements under MAP-21, the USDOT will review MPO planning documents every four years to assess that the agency is using a performance-based planning approach (USDOT, 2015).

FHWA addressed rules for all six performance areas through three rulemakings. The three rulemakings are referred to colloquially as PM1, PM2, and PM3. PM1 covers safety, PM 2 covers bridge and pavement conditions, and PM3 covers system performance, freight movement, and air quality.

3.5.2 The Impacts of Public Input

The vague language in MAP-21 requiring uniform performance indicators left a lot up for interpretation by the USDOT in deciding the exact measures to define. The first major change to a rule after public comment on a notice of proposed rulemaking (NPRM) came after FHWA published the NPRM for PM1. Although SAFETEA-LU is often referred to as the first surface transportation act that fully embraced multi-modal transportation modes, many advocates and professionals did not see MAP-21 following with similar attention to non-automobile modes. Enough people and groups perceived the lack of attention to safety for non-motorized road users in PM1 and commented accordingly. FHWA added the requirement to measure fatalities and serious injuries for non-motorized users based on the public commenting.

When PM3 was published in 2017, a last-minute delay by FHWA related to controversial sections of the rule related to greenhouse gas emissions (GHG) measure proposed by the Obama Administration (82 FR 22879). The GHG measure required reporting and target setting for the percent change in CO_2 emissions compared to the

calendar year 2017. Those in opposition to the measure do not believe that MAP-21 authorizes DOT to require a CO_2 measure. The stated goal in MAP-21 is to assess CMAQ projects: the stated purpose of CMAQ is to reduce "ozone, carbon monoxide, or particulate matter," but by measuring additional pollutants, it may be possible to track the efficiency in the use of federal funds to an even higher degree.

The Association of Metropolitan Planning Organizations (AMPO) and AASHTO issued a joint comment just days after the release of the NPRM for PM3 suggesting that additional time for public input was needed. Their letter questioned the DOT's interpretation of Congress' intent and anticipated a large amount of state and regional discussion moving forward due to the extent of requirements included in the rulemaking as well as the complex and controversial nature of the rule. (AASHTO and AMPO, 2016)

Normally, changes to a proposed rulemaking – such as indefinitely delaying certain sections – would have to go through a public commenting period before the final rulemaking could be put into effect. However, according to the *Federal Register*, "Given the imminence of the effective date of the PM3 Final Rule, seeking prior public comment on this delay of the GHG measure would be impractical" and that "Good cause exists to suspend the effective date of the GHG measure without notice and comment." (Federal Registrar, 2017).

According to the latest finalized versions of the rules, by the fall of 2018, states and MPOs will need to report on performance measures and targets relating to National Highway System (NHS) performance, freight movement on interstates, and the Congestion

Mitigation and Air Quality (CMAQ) Improvement Program for PM3 along with the measures established in PM1 and PM2.

3.6 Equity and Justice

As Mazmanian and Sabatier (1983) emphasize, performance measures or indicators should meaningfully and directly address the stated or inferred objectives and outcomes of a policy. Measuring justice and equity impacts in quantifiable terms is a complicated process as equity can be defined in many different ways, incorporated in multiple stages of the transportation planning processing, and assessed on varying scales. Furthermore, the interaction between transportation and land value brings in additional planning and land use variables into play when evaluating quality of life, the cost in time and money in commuting to work, and other elements (Brodie, 2015; Manaugh et al. 2015; Rescher 1966). In order to measure equity, an agency first needs to decide how they will define equity and what elements of social and distributive justice they will measure directly. Figure 6 shows how equity can be viewed as the factors that contribute to justice.

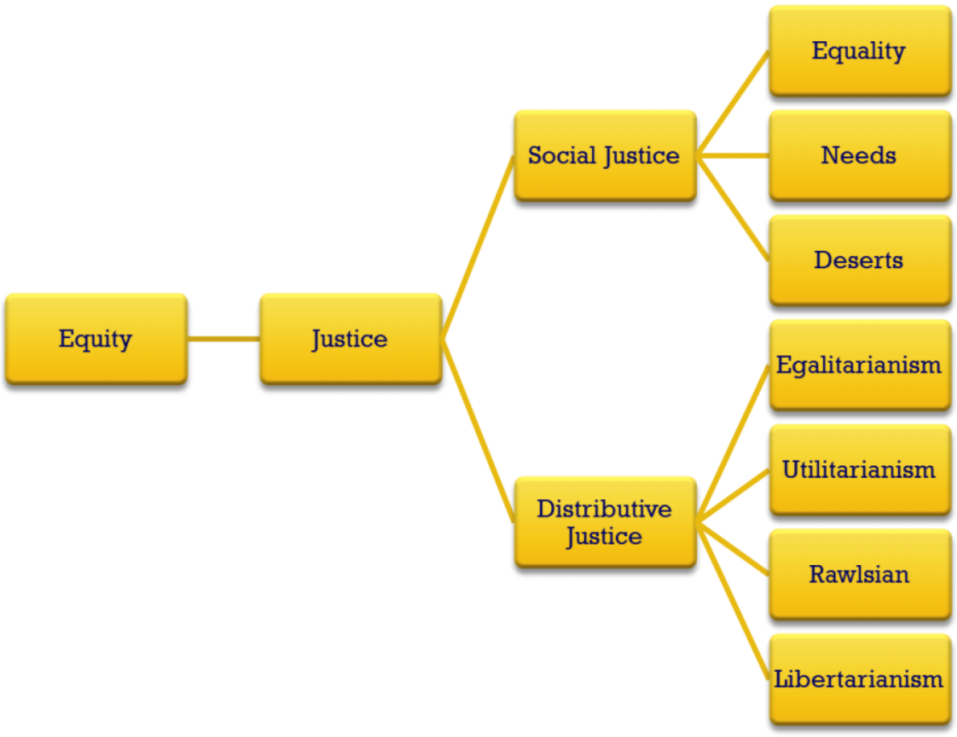


Figure 6 - Elements of Equity and Justice

Source: Brodie, 2015

Measuring any element in the far right column across geographies, wealth levels, race, or other groups of interest can help an agency measure and track equity as well as set targets to meet equity related goals. Neither MAP-21 nor the FAST Act include equity considerations in the stated goals or objectives. However, based on a 1994 executive order by President Clinton, all federal agencies are required to consider environmental justice for minority and low-income populations (59 FR 7629). The performance areas also do not mention equity considerations, and perhaps as a direct result, the performance measure requirements in PM1, PM2 and PM3 do not include and measurement of Equity.

Kevin Manaugh (2015) believes that "MPOs are now incorporating more social equity performance measures into their plans in response to the new guidance issued by USDOT on environmental justice and equity planning considerations in 2012." He identifies San Francisco, San Diego, and Boston as having objectives and measures environmental justice and equity, but believes few other metropolitan areas are quantifiably assessing justice. He also picks out Atlanta, Chicago, Boston, and San Diego as cities that pay close attention to accessibility to jobs for disadvantaged groups, a measure that is often used in equity evaluations, and singles out Houston, Minneapolis, New York and Seattle as metropolitan regions that have not set social justice goals at all. An assessment of performance measures addressing equity and justice is discussed in the analysis of this study.

3.7 Performance-Based Planning in Transportation Yesterday and Today

In 2001, many agencies were using a data driven approach to transportation project assessment. In their paper, Use of Performance Measures in Transportation Decision Making, Pickrell and Neuman suggested that beyond providing accountability for the use of tax dollars to the public, performance data can "suggest future implications of current or potential policies, plans, and programs." (Pickrell and Neumann, 2001). That same year, Meyer asked the question, "How can performance data that are designed to report on facility physical conditions be related to broader societal goals?" (Meyer, 2001). In a sense, MAP-21 tasked the USDOT with answering this question by setting goals and leaving the precise measure requirements up to the USDOT to determine. Meyer also outlines specific characteristics that he believes a performance-based planning process should exhibit, many

of which are examined in the data collected for this dissertation. The performance-based planning process introduced by Meyer is shown in Figure 7.

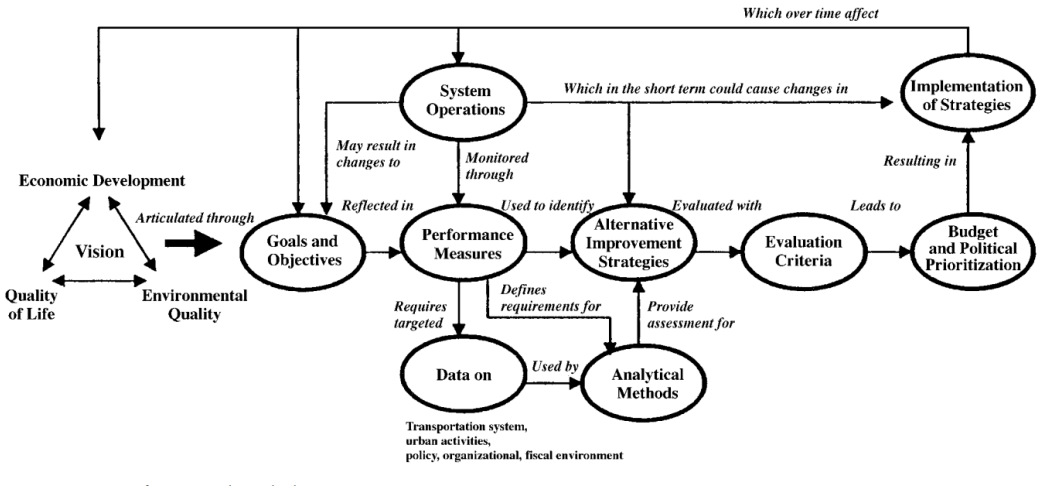


Figure 7- Performance-Based Planning Process

Source: Meyer, 2001

This dissertation focuses on the relationship between performance measures and how they are developed based on set goals and objectives, and how they affect prioritization and programming (shown in Figure 6 as broader "Alternative Improvement Strategies"). Few studies have assessed the direct relationship between federal goals and regional performance-based transportation planning, but relating measures to goals within the regional level is a task easier to tackle.

In 2008, Handy (2008) related changing goals at MPOs to their use of performance measures. By relating her analysis to the public involvement process, Handy emphasizes the role of reporting measures and targets in providing transparency and accountability to the public. Her analysis took into consideration the current federal transportation

legislation at the time, SAFETEA-LU, and relied largely on long-range transportation plans, consisting of four case studies selected based on prior knowledge of goings on at MPOs. The four cases studies include the Metropolitan Transportation Commission in the Bay Area in California, The Sacramento Area Council of Governments, The Puget Sound Regional Council in the Seattle Region in Washington State, and the Metropolitan Council in the Twin Cities Region in Minnesota. Handy found that different agencies measured similar goals such as reducing congestion, in different ways, suggesting that while the USDOT measures may address certain goals well, previous efforts by agencies that included different metrics might also have addressed the same goals and performance areas. Handy concludes that relating goals with performance measures tied to them, particularly measures that relate to implemented travel demand models, will be most weighty in the transportation planning process (Handy, 2008).

After President Eisenhower spearheaded federal investment and authority in the national transportation system with the Interstate system, evolving transportation bills have passed through the legislative and executive branches to fund and spur regulation of surface transportation. Industry focus on using performance measures in transportation gained traction in the 1990s, following in the footsteps of other fields concerned public wellbeing, health, and safety and fiscal responsibility, and when MAP-21 passed in 2012, transportation performance measures were mandated to the states and MPOs for the first time.

CHAPTER 4. MPO SURVEY

The goal of the survey element of this dissertation research is to provide survey analysis that can inform MPOs, states, and the federal government to better understand the impact that MAP-21 has had to-date on regional performance-based planning, how different agencies are developing and using performance measures, and what barriers stand in the way of MPOs using performance-based planning. This section begins with a review of relevant existing survey efforts to examine the state of MPO planning and policy practice in light of MAP-21. The rest of the chapter introduce the study's survey design and deployment, descriptive statistics from the responses, and a closer examination of variables to model performance measure use and cluster agencies. This analysis will also open the possibility of using characteristic variables of MPOs to predict what performance metrics they may use or want to use. A synthesis of the results adds insight as to what degree federal legislation has influenced planning, engineering, and policy at the regional level. Results show what mandated and voluntary performance measures have been adopted by different agencies, how those measures related to other goals and qualities of the agencies, and how different types of agencies are dealing with the MAP-21 performance mandates.

4.1 Previous Findings in Performance-Based Planning in Transportation Today

Few national studies have been conducted assessing the adoption of performance-based planning in the context of MAP-21 at a regional level. Two recent survey efforts did ask representatives at MPOs about their agency structure and performance measures, and a study on transportation legislation from the 1990s shows that researchers, planners, and

advocates have been interested examining the effects of federal legislation on urban transportation planning for decades.

A 2017 Performance Measure Survey conducted by the research and advocacy group, Transportation for America (T4A), includes survey responses from MPOs on questions about performance measure adoption. T4A's stated goal of the survey was to establish a state of the practice. They received responses from 104 MPOs and found three quarters of their sample to be using performance measures in any way at the time of the survey, but far fewer (about 30%), incorporating performances measures into TIP project evaluation.

T4A found that although MPOs are often grouped into size in discussion about their planning practices, half of the respondents that had not yet adopted any performance measures had regional populations of over 500,000 people. The survey report does not go into more detail about size or any other characteristics of regions that may be related to if or how an MPO may be using performance-based planning. In response to their question about what barriers stand in the way of MPOs doing performance-based planning, many agencies reported a lack of data as the problem. When given the option to select "resistance from the public" as a barrier, only three of the 104 agencies selected it. In both the 2017 survey, and their 2015 report Measuring What We Value, T4A emphasizes the benefits of the MAP-21 requirements in increasing transparence and accountability in the impact of the use of public funds.

As mentioned by T4A, many agencies cite a lack of data as preventing them from being able to conduct performance-based planning. T4A also suggests that data

deficiencies may sometimes be more of an agency perception than a reality. One solution to insufficient collection for access to data at one MPO is to share data with peer and nearby agencies. A 2018 study by Grossman et al. showed that 79% of MPOs responding to their survey used traffic (vehicle, bicycle and/or pedestrian) volume data that they acquired from other agencies, largely from their DOTs. Data sharing from the state to the MPO was especially prevalent for smaller MPOs.

In 2017, FHWA published a second study by Jeff Kramer et al. that examined staffing and governance at MPOs examining the relationships between personnel and planning operations at agencies. The Bond et al. survey received responses from 305 MPOs. 90 percent of MPOs that responded to their survey claimed to have developed performance measures in the LRTPs (Kramer et al., 2017). Those measures may or may not match up with the federal requirements. The mismatch with the 30 percent of agencies in the T4A survey reporting the use of performance measures could be due to agencies putting measures in their LRTP that they have not yet begun to use, or to the difference in sample size. The Kramer report, which focuses on MPO staffing and organizational issues, notes that while around seventeen percent of agencies have staff who spend more than half their time on performance-based planning, most responding agencies (about 80 percent), have not seen workloads increase more than 20 percent due to implementation of performance-based planning. Agencies noted different ways of incorporating the new element, some reallocating resources, and some discussing hiring more interns. Figure 8 shows in what ways the MPOs surveyed by Kramer et al. are incorporating performance measures into the planning processes.

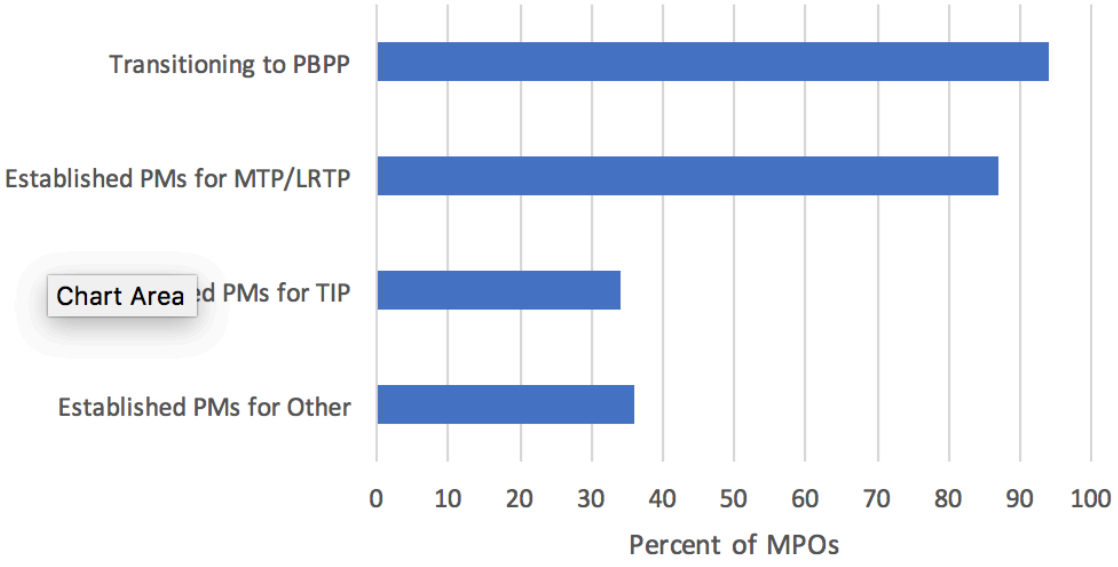


Figure 8 - MPO Usage of Performance-Based Planning and Programming

Source: Kramer et al., 2018. N=241 MPOs

The study found the average population of MPOs that have established performance measures for both the MTP/LRTP and the TIP as over 450,000, and the average population that have established performance measures for the LRTP, TIP, and at least one other program is 850,000 people, suggesting that medium and large MPOs (above 200,000 people) have gotten further through the process of incorporating performance-based planning overall. A closer examination of what types of measures agencies were using showed that MPOs most often used performance measures for safety and congestion management programming. This makes sense as data for vehicular congestion has been collected in a standard manner to examine travel times and VT for many years. Additionally, the first rulemaking to come out was for safety. Table 2 further breaks down the usage of performance measures into agencies that have adopted performance-based planning into some or multiple levels of their planning and programming.

Table 2 - Distribution of MPO Usage of Performance Measures

Established PMs for:	Number of MPOs	Percent of MPOs
MTP/LRTP Only	75	43%
MTP/LRTP and TIP	35	20%
MTP/LRTP, TIP, and Other	21	12%
MTP/LRTP and Other	21	12%
TIP only	2	1%
TIP and Other	1	1%
Other Only	20	11%
Total	175	100%

Source: Kramer et al., 2018

Table 2 shows that well over a hundred, or more than 25 percent of all MPOs in the country, have incorporated performance measures in the long-range planning process. While many of these agencies have yet to establish measures in their short range, constrained plans, they may be tying measures to goals or visions of the agency that are also covered in the long-range plans, which is a logical starting point in transitioning to performance-based planning.

In the early 2000s, the National Center for Biking and Walking (NCBW) saw major changes in national policy in ISTEA and TEA-21 relating to biking and walking and began looking at MPO planning processes as "rational transportation policy requires strong planning and execution at the regional level." The NCBW worked with the Association of Metropolitan Planning Organizations (AMPO) to conduct a survey of all MPOs in the country to assess their regional bicycle and pedestrian planning. The NCBW kept the survey short with only 12 items for MPOs to respond to, asking about time and money

spent on specific issues, and the content of planning documents. The survey received 144 responses from 340 MPOs and generally found that many MPOs had not yet fully incorporated requirements for TE or CMAQ funding, and all agencies cited barriers to reaching goals included in the recent transportation bills due to a wide variety of reasons, including a need for MPOs to ramp up staffing and expertise, and a lack of communication between MPOs and state DOTs (Chauncey and Wilkinson, 2003).

In a previous project, the NCBW set their own simple benchmarks and set out to see if states met them (Chauncey and Wilkinson, 2003). A few years later, the Alliance for Biking and Walking began publishing their periodic Benchmarking Report that reports on standard, uniform performance measures in biking and walking (Alliance for Biking and Walking, 2010). This is just one example of how finding out what data are available and what data can be useful in specific contexts can help lead to better policies and resources that are used nationally for reference, education, and assessment.

In 2010, changes in legislation with SAFETEA-LU that assigned additional responsibilities to MPOs, just as MAP-21 does, also spurred surveys and studies of MPOs to examine planning processes and resources. A 2010 FHWA study looked at MPO governance, structure, and funding issues through a survey deployed to all MPOs with 133 complete responses (35.5% response rate) with a response rate of at least 30.2% within each MPO size classification and uneven geographical responses. Follow-up case studies included a more even geographic spread. This method of surveys followed by case studies is seen as a useful mechanism to inform both MPOs and partners such as state DOTs and consulting firms to see best practices and become aware of national trends (Bond, et al., 2010).

Overall, there is a lack of knowledge about where MPOs stand in the process of adapting to MAP-21 requirements for performance-based planning in terms of adopting performance measures, setting targets, and communicating with their state DOT. There is also little research on the scale at which MPOs are incorporating performance-based planning into their short- and long-range transportation planning processes. Understanding how many agencies are using required and non-required performance measures, when they began using them, and to what extent they are integrating them into their planning process will show where we are as a nation in the practice of performance-based urban transportation planning, and how federal requirements have influenced national practice.

4.2 Target Population

The entire population for the study includes the 405 MPOs that conduct regional transportation planning for all urban regions (50,000 people and up) in the country, listed in the FHWA and AMPO database (AMPO, 2016). A standard targeted response rate of 30% would yield responses from at least 122 agencies. Based on the literature, a 30% response rate would give survey analysis similar significance to previous studies on MPOs. Target responses for stratified samples included reaching at least 30% each of small, medium, and large MPOs as well as general geographic distribution and state political composition.

With 183 responses, this study exceeded the target response rate by reaching a 45 percent response rate. Table 3 shows the response rate within population, political leaning, and geographic zones and Figure 9 shows the definitions for each category as defined by the National Conference of State Legislatures and the United States Census Bureau.

Table 3 -Responding Agency Characteristics

	Stratification	Response Rate
Population	**50,000-99,999**	54%
	100,000-199,999	48%
	200,000-499,999	35%
	500,000-999,999	48%
	1 million or more	41%
State Legislature Political Leaning	**Red**	46%
	Blue	50%
	Purple (split)	41%
Geographic Region	**West**	54%
	Midwest	38%
	South	46%
	Northeast	46%

*Note that some MPOs fall into multiple categories when their metropolitan regions cross state lines and were thus counted more than once and placed in all appropriate categories

The National Conference of State Legislatures provides state house legislative control classification for each state based on the composition of the state legislature as of March, 2017. As states guide regional transportation planning through state law, state plans funding priorities, data sharing, and general collaboration, the priorities of the state legislature are relevant to MPOs. Regional classifications are defined by the United States Census Bureau Geography Division. Although the regions are broadly defined, they serve

as guidelines to examine geographical distribution and as a geospatial variable to describe regional agencies.

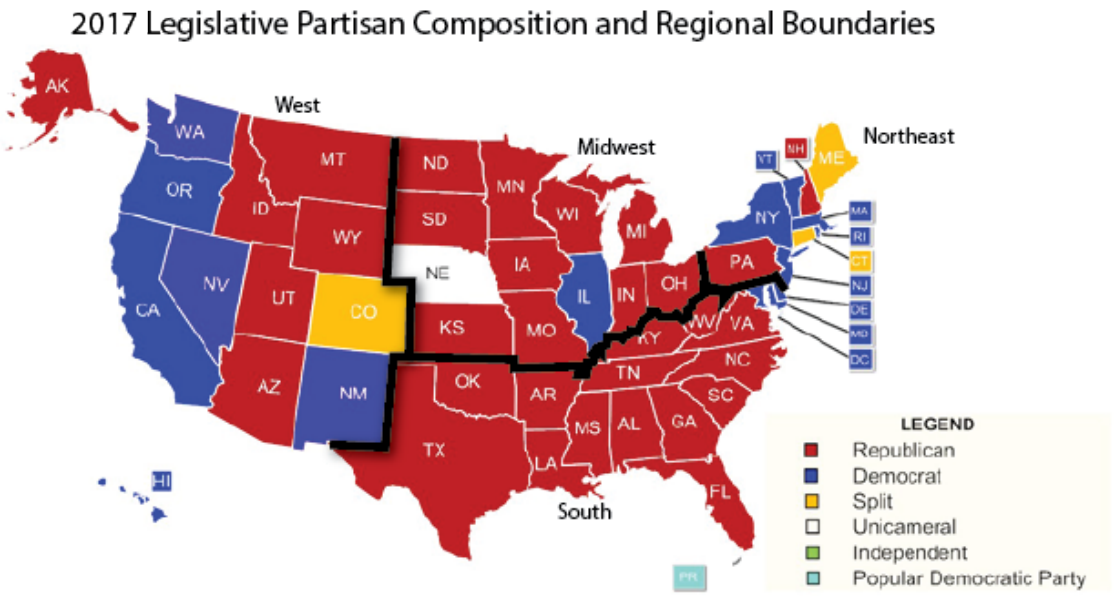


Figure 9 - State Classifications by Region and Political Party Control

Source: Modified from The National Conference of State Legislators

The stratified target responses all met the target response rate of 30 percent, ensuring that a variety of types of MPOs and urban regions are represented in the study. Even with high response rates in stratified groups, other elements of survey bias must be addressed as outlined in the next section.

4.3 Addressing Survey Bias

Interpretation of the survey results must include an understanding of the potential biases reflected in the data collected. Sampling bias and coverage bias are mute in the case

of this deployment as the sample consisted of the entire population of interest i.e. all MPOs in the country. Response and non-response biases may affect the results and analysis, and each are addressed below.

The survey was designed to elicit unbiased responses for all questions. Multiple choice options included the option "I don't know" allowing for respondents to complete each question and section even if they did not have a direct response to the question. The survey, was short, estimated at 10-15 minutes, to avoid survey fatigue.

Non-response bias must be taken into account, both on a full survey scale (unit non-response) and individual question scale (item non-response) (Richardson et al., 1995). Respondents were given the opportunity to skip any question in the form in order to decrease respondent frustration and increase the overall response rate. As the survey was short and concise, respondents were unlikely to skip questions. Item non-response was limited with very few respondents choosing to skip any questions. Results indicate the number of respondents that chose not to respond to a question when applicable to account for the item non-response. Particularly notable for potential non-response, the second section of the form asked for respondents to fill in a matrix indicating non-MAP-21-required performance measures used by their agencies, when they adopted each metric, why, and where the data came from. This question may have been perceived as work-intensive or daunting to some respondents and some voluntary metrics did not end up being recorded in all responses.

A variety of known and unknown elements contributed to unit non-response (Groves, 1989). Some of the agencies who chose to not respond to the survey contacted

the researcher to explain why. One agency staff member specified that they didn't have much to say because they were only going to use mandated measures and conduct minimal data collection. Another said that they could not complete the survey because there was no one person at the agency in charge who would know all the answers. Another potential respondent opted not to complete the survey they said because things are changing too fast and no one at the agency knows enough to be able to complete the survey. Even when these MPO staff were told that they would be able to indicate when they didn't know or couldn't answer a question and that their responses were still useful and important, they did not complete the survey.

One MPO staff member replied to a phone call asking if they would complete the survey stating that they would not because MAP-21 is not a genesis for performance-based planning, that it really began as far back as SAFETEA-LU with state congestion management processes leading to goals and objectives that were further developed into the performance measures devised by USDOT in accordance with MAP-21. This idea that each transportation bill builds on previous legislation is what makes MAP-21 so potentially influential. While there are still many barriers to agencies effectively implementing performance-based planning in transportation and the required areas and measures fall short of comprehensively covering an urban transportation network, MAP-21 is still a beginning and an important step.

It is possible that the results discussed in the chapter reflect a slightly skewed representation with fewer agencies who do not have staff in charge of performance-based planning, who feel that performance-based planning is not an important issue at the moment, or who see the area currently as unclear and quickly changing.

4.4 Survey Design and Deployment Methodology

Development of the MPO survey is structured around MAP-21 rulemaking and takes a "before and after" approach to asking about metric collection and use. The survey is designed to collect significant data on how MPOs collect and use quantitative data in transportation planning before and after 2012. It was deployed via e-mail to all 405 MPOs in the country (AMPO, 2016), specifically to senior transportation planners at each agency in January and February of 2017. A reminder e-mail and up to three phone calls to agencies after the e-mail dissemination helped significantly raise the response rate from around 10 percent to 45 percent.

Survey questions cover: 1) background information and characteristics; 2) what performance measures are collected and how they are used; 3) when, in relation to the passing of MAP-21, the MPO began collecting and using performance measures; 4) funding allocations; 5) what roadblocks exist for performance-based planning implementation.

The 12-minute online survey included questions about basic characteristics of the agencies, mandated and voluntary performance measures collected and used, barriers to performance-based planning, and optional follow-up contact information. The survey was pre-tested by former MPO staff and revised before deployment. The survey is designed online with the platform JotForm, which ensures data security and allows for customized question types. The survey flows as seen in Figure 10.

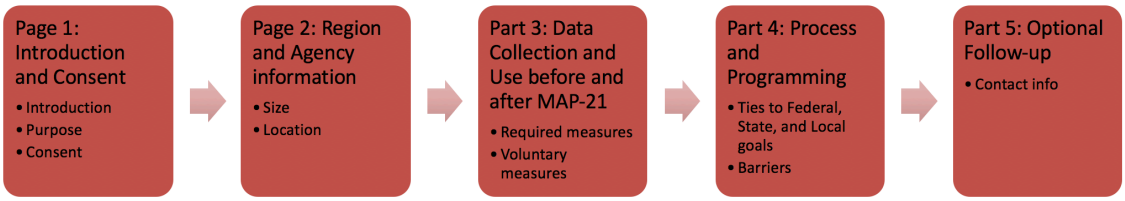


Figure 10 - Survey Flow

The first page of the survey tells the user the purpose and background of the survey and shows the required consent information as stipulated by the Institutional Review Board (IRB). The second page of the survey is short and opens with easy questions about the agency to draw the user in. Page three then delves into the questions about data collection, target setting, and integration of metrics and targets in the planning process. Users were asked about agency practices before MAP-21 and then after. The survey instrument in Appendix A lists the relevant metrics, worded exactly as they are in FHWA rule-making for clarity and consistencies for agencies responding to the survey. Page four asks whether or not funding availability has increased since the passing of MAP-21 for data collection and analysis at the local, state, and federal levels. The last page asks for contact information for potential follow-up, particularly for case studies. The body of the distributed email served as a cover page for the survey and is currently under development. The full survey instrument can be found in Appendix A.

The survey was sent to Transportation Planners at every MPO in the country. The USDOT and AMPO list of agencies served as the reference database for consistency (AMPO, 2016). Names and contact information for transportation planners for each agency were collected manually and recruitment occurred through email including one

follow-up reminder. Phone calls to individuals after two email invitations to complete the survey significantly improved the response rate from around 10 percent after the initial email invitation to participate to 45 percent after phone calls.

4.5 Survey Results and Analysis

This section begins with descriptive statistics to show who responded to the survey and display some of the general trends in responses for some of the questions. Linear regression models show what characteristics and practices at MPOs predict the use of more MAP-21-required variables. Logistic regression models predict the use of voluntary measures, and the cluster analyses that follow were informed by exploring the data to select relevant and significant variables while minimizing collinearity. The section ends with a discussion of the more qualitative data collected through open ended comments at the end of the survey.

4.5.1 Descriptive Statistics

The 45% response rate provides a comfortable sample to analyze, and as seen in Table 3, adequate representation from agencies with various population sizes and other characteristics are included in the survey responses. Figure 11 shows the distribution of respondents from each MPO population group.

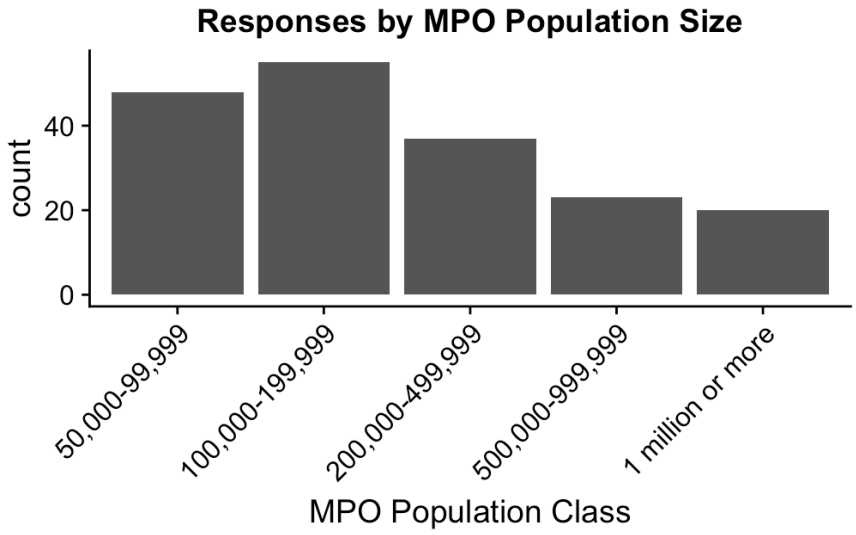


Figure 11 - Responses by MPO Population Size (n=183)

Small MPOs with populations under 200,000 people comprise 103 responses of the total 183 responses (56 percent of the respondents), representing small MPOs as just over half of the respondent pool, which corresponds closely to the share of small MPOs in the country, which lies at about 56 percent of all MPOs. Also following from Table 2, it is worth noting that a large majority of MPOs are located in red states (states with republican control of the state legislature), and in states located in the South. When modeling behavior based on characteristic variables such as the analysis later in the sections does, distributions and outliers can have an effect on the models. Although some agencies who responded to the survey have regional populations high above the rest of the agencies, for example in the New York, San Francisco, and Chicago regions, grouping populations in the five categories shown in Figure 14 helps to mitigate the outlier problem, as well as to make the question or the regional population easier for respondents to answer, even though information of exact populations is lost.

Consolidating populations into groups also allows for easy to read and understand crosstabulation analyses. Tables 4 and 5 show crosstabs of population with the use of MAP-21 mandated and voluntary measures, respectively. The categories for MAP-21 performance measure use break into using zero of the 19 required measures, "low" which is using 1 to 10 of the required measures, and "high" which means using more than 10 of the required measures.

Table 4 - Population and Map-21 Performance Measure Use Crosstabulation

n=183	Number of MAP-21 PMs Used		
MPO Population	None	Low	High
50,000-99,999	12	13	11
100,000-199,999	14	22	19
200,000-499,999	4	18	15
500,000-999,999	1	6	16
1 million or more	0	7	13
Grand Total	16.9%	40.4%	42.6%

Table 4 shows that while the majority of agencies do not yet have a high adoption of MAP-21 performance measures, large MPOs with a population of over one million are much more likely than their smaller counterparts to have high levels of adoption and less likely to have low levels of adoption. With 8 degrees of freedom, a chi square test gives a value of 25.6, which is high enough to reject the null hypothesis that there is no relationship between regional population group and how many MAP-21-required measures an MPO uses. The positive relationship between performance measures adoption and regional population holds true as well for likelihood of having adopted any voluntary performance

measures as can be seen in Table 5 which presents crosstab results for regional population with a binary yes or no for whether or not the agency listed any voluntary performance measures.

Table 5 - Population and Voluntary Performance Measure Use Crosstabulation

n=183	Use of Voluntary Performance Measures	
MPO Population	No	Yes
50,000-99,999	38	10
100,000-199,999	46	9
200,000-499,999	22	15
500,000-999,999	16	7
1 million or more	9	11
Grand Total	71.6%	28.4%

The chi square statistic value of 14.95 is significant for a 95% confidence level to reject the null hypothesis that there is not a relationship between collecting voluntary measures and population size. Table 5 also shows that small MPOs, with regional populations under 200,000, are much more likely to not have adopted any voluntary performance measures. Chi squared tests show that the geographic region of the MPO is statistically significant at 95% for the use of voluntary performance measures but not MAP-21-required measures.

Tables 6 through 10 show a closer examination of how many agencies adopted different measures before and after MAP-21, not at all, or if the survey respondent did not know. The lowest item response rate is 165 agencies, which still provides a 41% response rate.

Table 6 - Agency Responses Regarding MAP-21-Required Safety Measures

Safety Measures						
Measure Adoption Timeframe in Relation to MAP-21	# of serious injuries (n=172)	Rate of serious injuries (n=167)	# of fatalities (n=170)	Rate of fatalities (n=166)	Number of non-motorized serious injuries (n=165)	Number of non-motorized fatalities (n=167)
before only	12%	9%	17%	11%	11%	14%
after only	39%	39%	35%	37%	39%	37%
before & after	24%	20%	29%	23%	16%	18%
never	20%	26%	15%	22%	27%	25%
I don't know	4%	7%	4%	7%	7%	7%

Table 6 shows the adoption rate most of the required safety measures at around or just above 75 percent. The "before only" responses are surprisingly high, as the option was given just in case an agency had collected a performance measures in the past that they no longer collected. It is likely that respondents were confused and indicated "before only" in cases that might actually be "before & after" as they may actually still be using the measure, and it is now after MAP-21. 87 out of the 165 (53%) agencies collected all required safety measures. The Safety Rulemaking came out March 16, 2016 before any of the other MAP-21 rules with mandated performance measures and is often referred to as "PM1." PM1 was followed by PM2 covering bridge and pavement performance and PM3 for system performance. As discussed in the previous chapter, the initial safety measures notice of proposed rulemaking (NPRM) was issued in spring of 2014 and the final rule for PM1 came out in 2016. The major changes for the final rule from the NPRM included adding the measures for non-motorized fatalities and serious injuries. Even before the passage of MAP-21, USDOT published guidance on how agencies could go about utilizing performance measures in transportation planning, and recommended performance measures included number of fatalities for vehicle occupants, motorcyclists, and pedestrians, and serious injuries in all traffic crashes (Herbel, et al., 2009). Serious injury

and fatality data have been publicly available since 1975 through the Fatality Analysis Reporting System (FARS). The high availability of data and guidance, the length of time between the NPRM and final rule and date of this survey distribution, and the general acceptance of safety as an important element in transportation planning, all lead to the number in Table 6 as yielding a somewhat surprising result.

The measures listed in Table 7 are from the bridge and pavement PM2 rulemaking. The measures include pavement and bridge conditions along interstates and the National Highway System (NHS). There are a few MPOs who responded to the survey who noted that they don't have either interstate or NHS roadways in their jurisdictions, but it's rare.

Table 7 - Agency Responses Regarding MAP-21-Required Infrastructure Condition Measures

Infrastructure Condition Measures						
Measure Adoption Timeframe in Relation to MAP-21	% main line interstate lane miles in "good condition" (n=167)	% main line interstate lane miles in "poor condition" (n=165)	% main line non-interstate NHS in "good condition" (n=165)	% main line non-interstate NHS in "poor condition" (n=164)	% of NHS bridges in "good condition" (n=163)	% of NHS bridges in "poor condition" (n=166)
before only	7%	6%	10%	19%	13%	13%
after only	30%	30%	39%	38%	30%	32%
before & after	9%	11%	10%	9%	13%	13%
never	43%	44%	31%	35%	36%	34%
I don't know	11%	11%	10%	10%	8%	8%

Overall, many agencies adopted the PM2 performance measures after MAP-21. It also is seen that more agencies were measuring bridge performance than interstate performance before MAP-21. Since MPOs don't generally pay for interstate pavement projects, or NHS, the measures used for those requirements are less likely to tie into regional project prioritization, or appear to be helpful to the MPO staff. From a national perspective, the

aggregated data from all MPOs will help give a snapshot of the performance of national roadway pavement and bridge performance.

Table 8 shows the adoption of congestion related performance measures, and Table 9 shows system reliability measures.

Table 8 - Agency Responses Regarding MAP-21-Required Congestion Reduction Measures

Congestion Reduction		
Measure Adoption Timeframe in Relation to MAP-21	Excessive delay per capita (annual hrs of peak hr) (n=165)	% of non-SOV travel (n=170)
before only	8%	9%
after only	15%	11%
before & after	12%	11%
never	55%	51%
I don't know	9%	13%

Even though the performance measures in Table 8 weren't effective until more than a year after PM1, and MPO staff completed this study's survey a few months before PM3 came into effect, the fact that the majority of responding agencies responded that they "never" collected the delay or non-SOV travel measures seems very high. Comments on the survey included multiple agencies that specifically noted that they collect additional metrics beyond the Congestion Management Process (CMP) requirements. Some agencies that collect measures for CMP haven't yet caught up to the MAP-21 requirements, but may be able to do so more easily than other agencies since they have collected and used related data before. Based on Kramer et al.'s 2018 findings that many agencies were interested in measuring congestion performance for congestion management and on the availability of

vehicular congestion data, it is likely that many other MPOs use MAP-21-required or voluntary measures that use congestion data for similar purposes.

Table 9 - Agency Responses Regarding MAP-21-Required System Reliability Measures

	System Reliability (person-miles)		
Measure Adoption Timeframe in Relation to MAP-21	Reliable TT on interstates (n=165)	Reliable TT on non-interstate NHS (n=167)	Reliable Truck TT on non-interstate NHS (n=167)
before only	4%	3%	2%
after only	20%	22%	20%
before & after	9%	13%	5%
never	55%	54%	61%
I don't know	12%	9%	11%

Very few agencies were using the exact travel time measures required under PM2, but many agencies began collecting them fairly easily in part because they already had the data and may have been using slightly different metrics to achieve a similar performance evaluation.

The environment measures in Table 10 are not required for all MPOs, so the levels of adoption should be considered in context.

Table 10 - Agency Responses Regarding MAP-21-Required Environmental Measures

Environmental		
Measure Adoption Timeframe in Relation to MAP-21	% change in CO_2 emissions (Compared to 2017) (n=169)	Tons of emissions reduction from CMAQ projects (n=170)
before only	4%	15%
after only	7%	7%
before & after	8%	15%
never	70%	55%
I don't know	11%	8%

The carbon dioxide measurement was removed, for now, and would have only required for large MPOs (regions with a population over 1 million) non-attainment areas. The (Congestion Mitigation and Air Quality) CMAQ measures are only required for CMAQ funded projects in non-attainment areas.

In order to assess general levels of performance-based planning and estimate what characteristics of MPOs will predict various levels of performance measure use, new variables were created based on how many MAP-21-required and areas of additional voluntary measures. Figure 12 shows how many MPOs adopted how many required measures at any point in time.

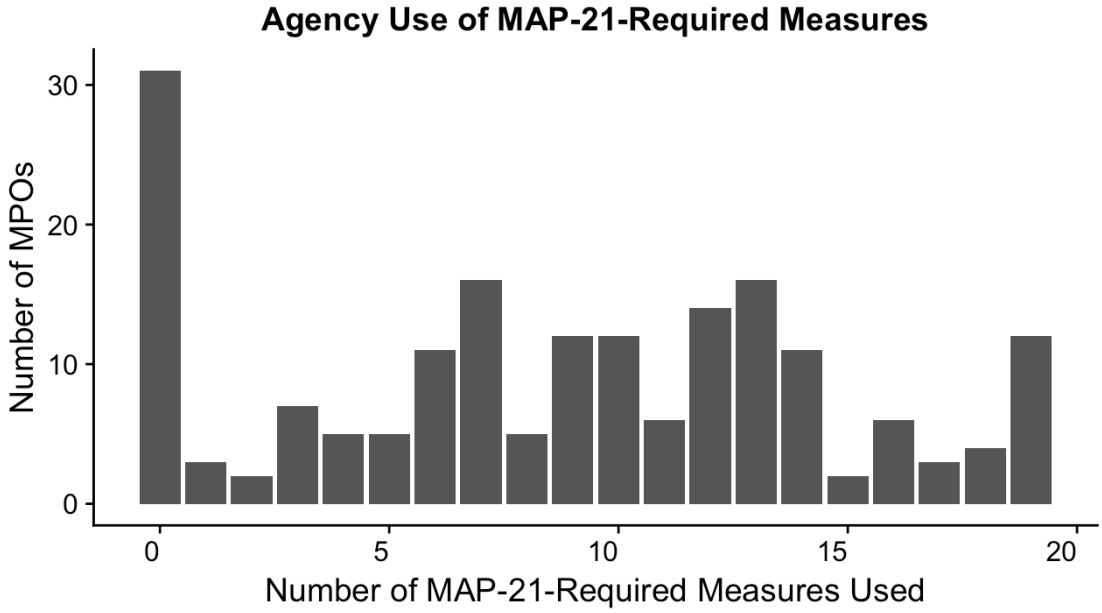


Figure 12 - Distribution of Agency MAP-21-Required Measure Adoption (n=183)

As can be seen in the histograms in Figure 11 and Figure 12, when removing the 31 agencies who collected zero MAP-21-required measures at any time, as well as the eight agencies with scores above 40, there is a fairly uniform distribution of how many required

measures agencies are adopting for their transportation performance-based planning. 12 of the 183 agencies (~7%) indicated that they had adopted all nineteen of the federally required performance measures, and eight of those adopted all the measures only after MAP-21. Three of the agencies that have adopted all 19 are located in blue states, which is precisely proportional to the number of blue states in the entire country (25%). Five of the 12 agencies (42%) also collect voluntary performance-measures, compared to just 28% of the entire sample of agencies collect voluntary performance measures.

Figure 12 shows how many MPOs adopted how many required measures only after MAP-21.

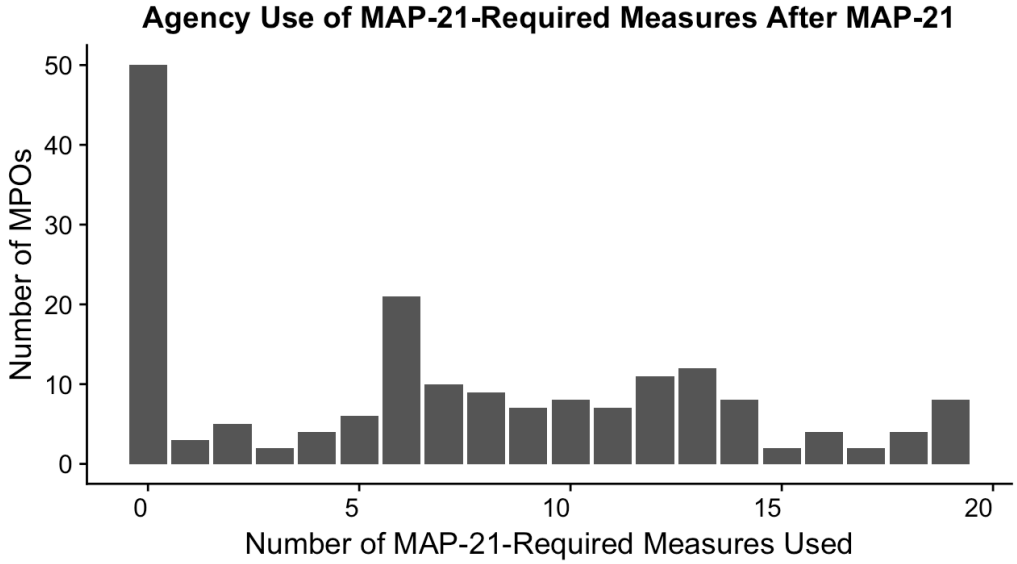


Figure 13 - Distribution of Agency MAP-21-Required Measure Adoption Only After MAP-21 (n=183)

There is also a fairly uniform distribution of adoption of performance measures after MAP-21, though 50 agencies (27%) did not adopt any required measures after MAP-21. Eight of the 12 agencies only reached full adoption of all 19 measures after MAP-21.

A further in-depth look at the performance areas for voluntary measures provides additional insight to agencies' planning priorities. Performance areas of transit, walking, bicycling, environmental sustainability, accessibility, freight, and equity were identified and key word data mining of the additional performance metrics entered by respondents led to an identification of agencies collecting performance measures in these areas. Most of the voluntary performance measures used by MPOs fall under the categories of bicycle and/or pedestrian planning, transit (mostly related to the National Transit Database), environmental assessment, and various areas of asset management. Figure 14 shows the number of agencies, grouped by size (large MPOs are agencies in regional populations of over 200,000 people), that listed performance measures in areas of walking, bicycling, emissions, accessibility, and freight.

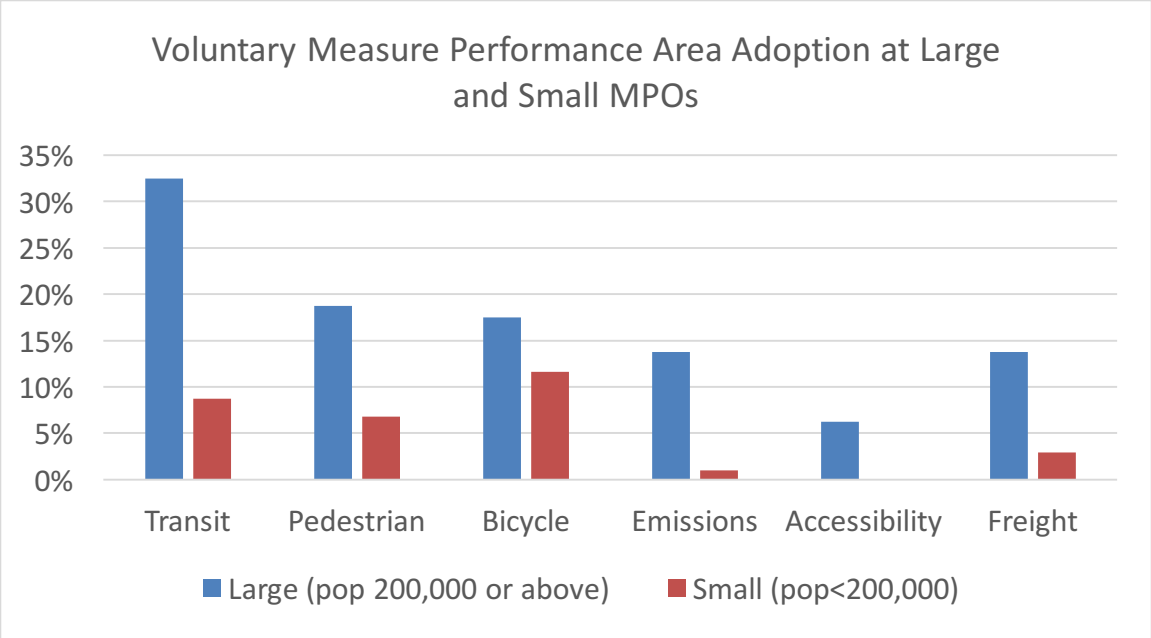


Figure 14 - Agency MAP-21-Required Measure Adoption After MAP-21 Distribution (n=183)

Small regions have not adopted accessibility measures, and fewer have adopted freight and emissions measures. Bicycling measures, however, have been adopted by a large proportion of small MPOs (12%), compared to the other performance areas.

Not a single voluntary measure listed by agencies responding to the survey used the word "equity." This is not to say that no agencies are measuring equity – they may be doing so using other terminology or not have included the measure in the survey – but it does suggest that there is likely not as widespread measurement of equity as measures towards other transportation goals. Interestingly, the 2017 T4A survey responses indicated that almost half of the respondents were interested in measuring the combined performance area of "equity and/or health" (Transportation For American, 2017).

One of the goals of using performance-based planning is to be able to track progress towards goals and objectives and evaluate spending and prioritization towards reaching those goals. The survey asked respondents if the measures they used were tied to region or state goals and objects as well as to region or state project prioritization criteria. Respondents listed each area they tied with performance measures and could list as many answers as they wanted. Figure 15 shows the number of agencies indicating each response.

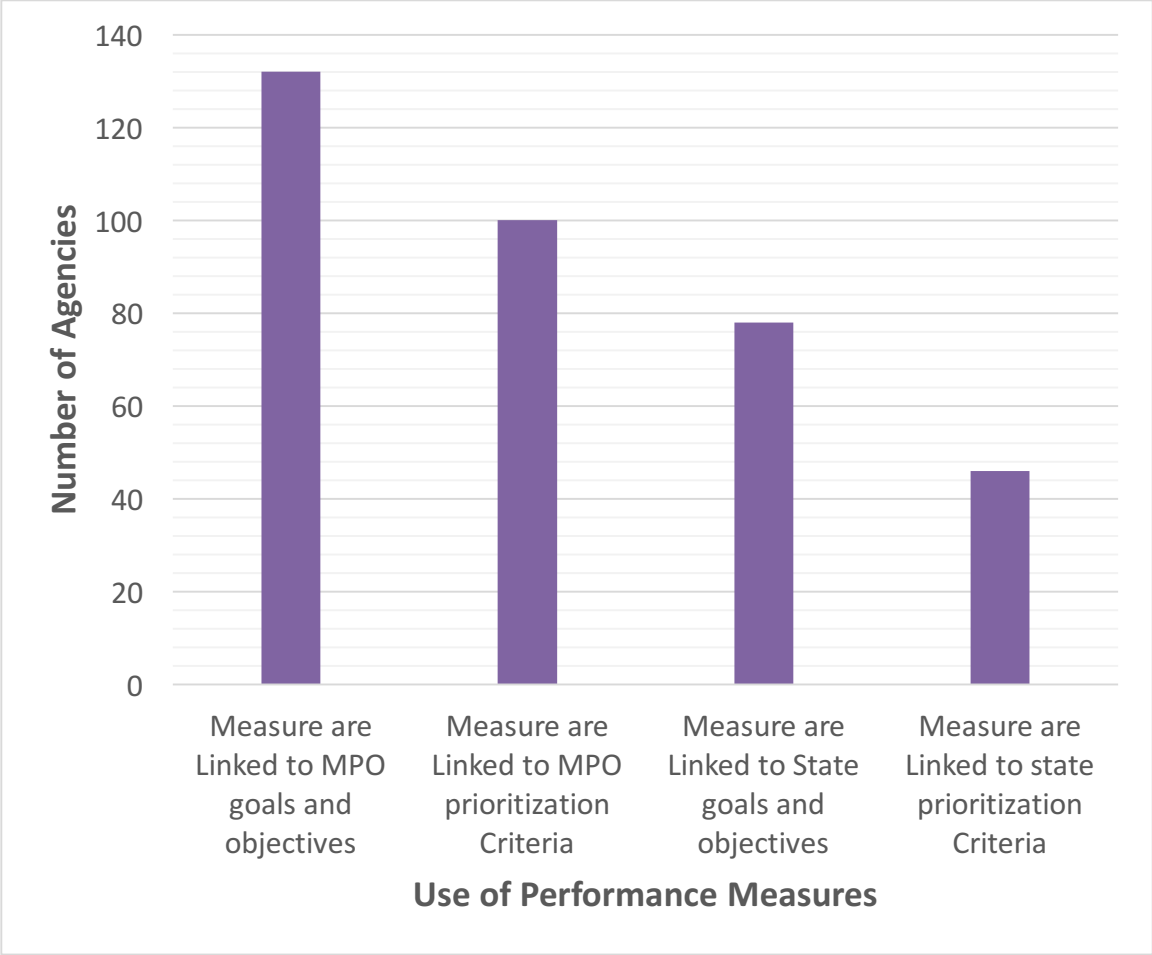


Figure 15 - Responses to "How does your agency use the adopted performance measures in the planning process?"

Most MPOs indicated linking measures to their own goals and objects and/or prioritization criteria, and some indicated measures linking to state transportation planning elements. As states begin setting targets (they had not yet set the PM1 targets when MPO staff completed the survey, linkages to state goals may increase since many MPOs seem to plan to adopt state targets, at least to begin with. Since staying accountable for stated goals and measuring progress towards meeting them, especially through project evaluation, is one of the purposes of using performance-based planning, ideally the linkage to of performance measures to goals, objects, and project prioritizations should be ubiquitous among

agencies. Since 31 agencies did indicate that they do not use any of the MAP-21-required measures, it would makes sense that those agencies would not indicate tying measures to planning practices. MPOs that do and do not yet use performance measure indicated what the barriers are collecting and using data in transportation planning. Figure 16 shows how many agencies listed each barrier, and respondents were allowed to list as many barriers as they wanted.

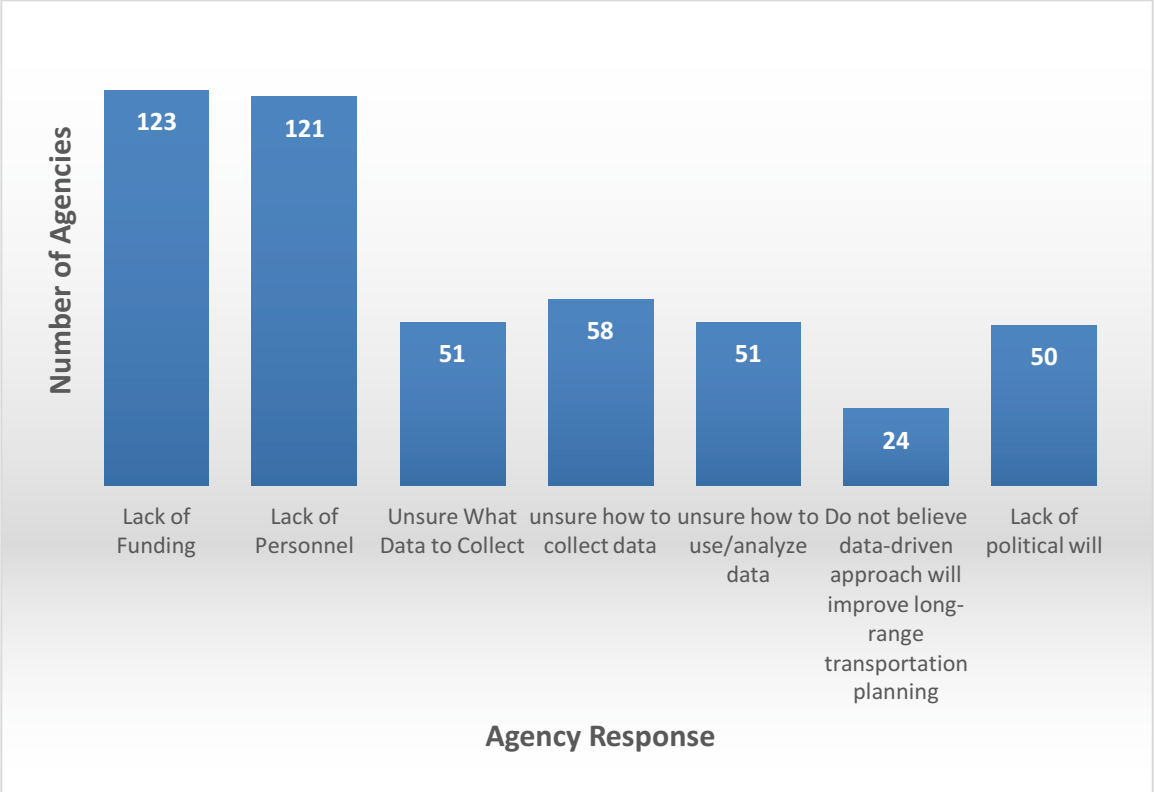


Figure 16 - Factors Preventing MPOs from Collecting & Utilizing More Quantitative Data

Most agencies listed a lack of funding and a lack of personnel as the major barriers to conducting performance-based planning. These factors may be related, and could potentially be grouped as a general lack of resources, which is a different type of problem than a lack of political will or lack of belief in a data-driven approach, which are more

ideological factors. Of the 24 agencies that list "Do not believe data-driven approach will improve long-range transportation planning" as a barrier to conducting performance-based planning, 11 respondents still listed voluntary performance measures used by the agency. Additionally, two of those 24 agencies indicated that they collected all performance measures required under MAP-21 (one of whom also listed additional voluntary performance measure and one that did not). Of the three agencies that claimed this barrier as the most important barrier, none collect voluntary measures or all MAP-21-required measures.

Some agencies informed their planning efforts by reviewing what other MPOs, DOTs, or other transportation agencies do. Figure 17 shows how respondents answered the question, "When developing performance measures for transportation planning, did your agency review practices at peer agencies?"

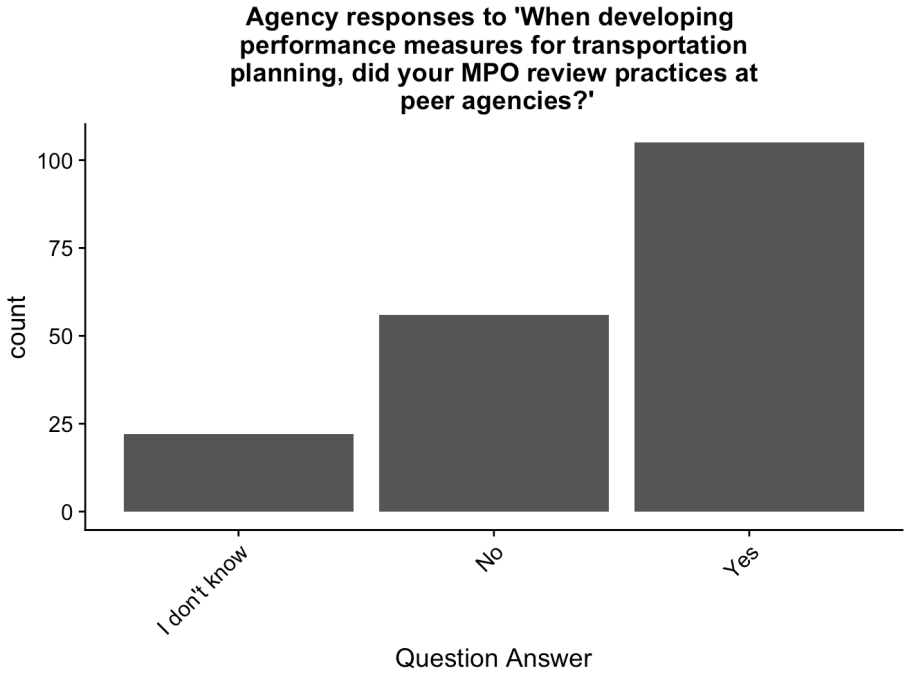


Figure 17 - Peer Agency Review (n=183)

105 MPOs indicated that they reviewed practices at peer agencies when developing performance measures for transportation planning. Nearly all of the 105 organizations looked at other MPOs, largely in their own states and geographic region of the country. Many looked to state DOTs (mostly their own states), and some to FHWA as well. This peer exchange, along with previous findings that regional and state agencies often depend on each other for data sharing, indicate overlap and room for collaboration to more effectively collect and use data (Grossman et al., 2018).

In some states, MPOs already coordinate extensively with each other. The Central Florida MPO Alliance is one example of five neighboring MPOs collaborating with each other and the state DOT (Seggerman and Kramer, 2012) to conduct regional planning on a larger scale than where the boundaries for each MPO end. It does not appear through available documentation that the MPOs coordinate performance measurement, but three of

the agencies in the alliance mentioned MetroPlan in their survey responses, and one indicated that MetroPlan is working on coordinating performance-based planning for the 2045 long range transportation planning efforts.

The interaction between metropolitan regions that creates a complex network across current governance boundaries is the basis of Ross' (2009) recommendation for megaregions. Ross drives home the need to re-examine governance boundaries to better facilitate, model, and plan for economic development, which is a key element of transportation planning relating both the movement of goods and people. Without a formal structure for megaregions, creating alliances such as the Central Florida MPO Alliance is one way that MPOs and DOTs can better coordinate.

4.5.2 Variable Selection and Models

MPOs are often thought of grouped by size, and sometimes by state or budget or other characteristics. Few studies were found that have looked at the characteristics or practices of an agency that can best predict their level of performance-based planning or their level of compliance of the use of current and future MAP-21-required performance measures (see section 4.1 for survey literature review). This section examines what variables might be useful in modeling performance-based planning efforts.

The entire data set from survey results contains four types of variables about responding agencies that describe, 1) agency/regional characteristics; 2) performance measure use (both MAP-21-required measures, and voluntarily selected measures); 3) barriers identified by agencies as factors preventing them from using performance-measure; and 4) what goals and prioritization methods the MPO ties performance measures

to (if any). Though survey respondents answered only one question listing all the barriers to using performance measures, and one question listing goals and prioritization that measures relate to, each factor was broken up into dummy variables for analysis. Additional variables were created to assess an overall level of performance-based planning. Three binary variables were created: one that indicates whether an agency has adopted all of the nineteen performance measures (MAP_21_All_PMs_Collected), one that indicates if the agency collects all safety variables (Collected_All_Safety) and one that indicates whether an agency listed any voluntary performance measures (Voluntary_PMs_Colected_Binary). In addition, three summation variables were created: Sum_Weighted_MAP21_PMs, which sums the MAP-21-required variables collected by the agency weighted to give a variable a high weight if they began collecting it as a result of MAP-21; Num_Of_MAP21_PMs_collected, which sums up the number of required measures adopted by the agency at any time; and Sum_Voluntary_PMs, which sums up the number of identified voluntary performance measure areas of transit, bicycles, pedestrians, accessibility, emissions, and freight that the agency collects measures in. Appendix B has a data dictionary explaining each variable.

After scaling the data, a correlation matrix was computed for the entire cleaned data set to examine the correlations between variables. Since a normal distribution of the variables should not be assumed, a Spearman correlation was used (with very little difference compared to the Pearson correlation outputs as seen in Appendix C that were also examined). The matrix in Figure 18 shows the level of correlation between pairs of variables with darker and larger blue and red spots denoting higher correlation. Red shows

a negative correlation between variables, while blue shows a positive correlation between variables.

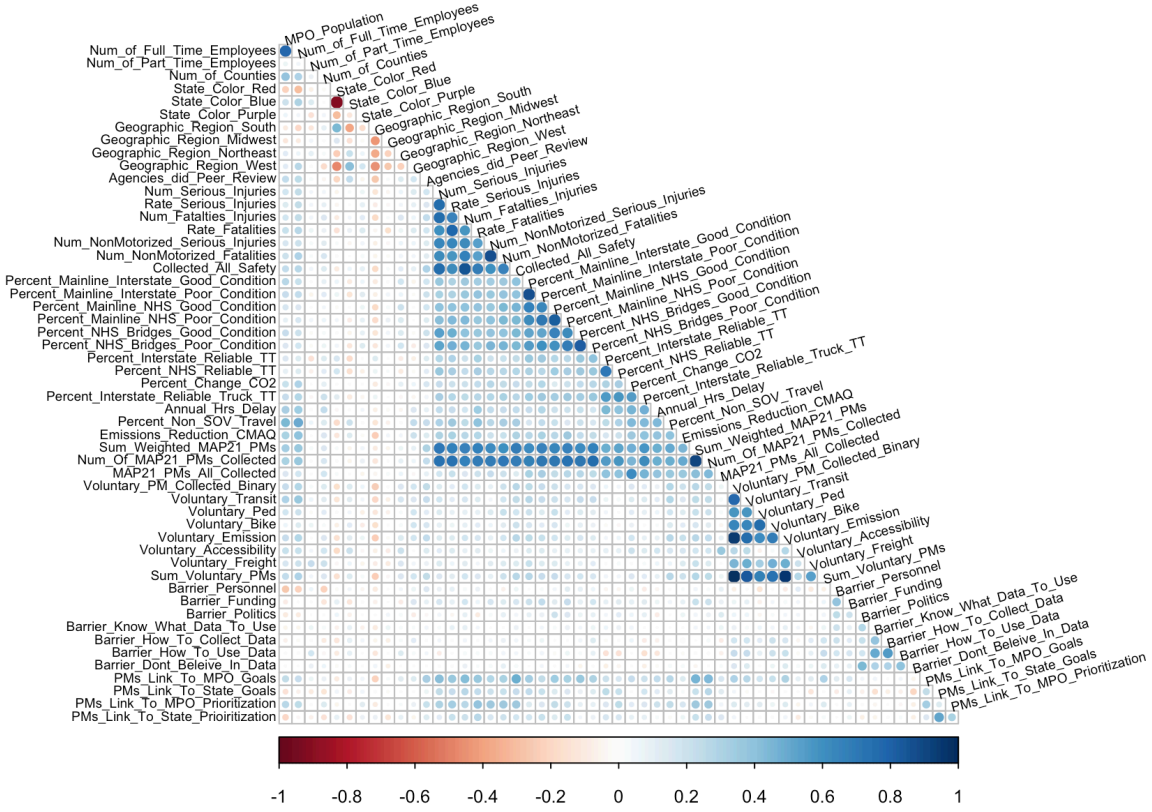


Figure 18 - MPO Characteristic, Performance Measure Use, Barriers to Performance Measure Use, and Links to Goals and Prioritization Criteria Correlation Matrix

Not surprisingly, results show that a proactive use of MAP-21-required measures (Sum_Weighted_MAP21_PMs and Num_Of_MAP21_PMs_Collected), highly correlates with collecting each individual measure required by MAP-21. There is also a positive correlation between collected required and voluntary measures suggesting that agencies who use any sort of performance measures are likely to use both mandatory and non-mandatory measures. Stronger correlation holds true within rulemaking groups, with strong

positive correlations among measures included in PM1, among those in PM2, and less so, but still visibly, for those within PM3. Also, agencies that choose to use measures in non-required areas of alternative transportation modes of transit, bicycling, and walking are likely to use measures in multiple of those categories.

There is a noticeable positive correlation between the use of MAP-21-required measures and linking performance measures to both regional and state goals, which makes sense because it would be very difficult to like measures to goals if the MPO does not use performance measures to begin with. However, a less strong correlation between linking voluntary measures to regional goals and prioritization criteria suggests particular focus on the MAP-21 measures, and a lack of correlation between state goals and priorities and voluntary measures show that these non-mandated measures are much more likely to be regionally specific and relevant and not result from MPO and state DOT coordination. There is a positive relationship between larger MPOs (more staff, and those in areas with larger populations) and linking measures to regional goals and prioritization criteria and a negative correlation between larger size and linking to state goals and prioritization criteria.

In general, there is a positive relationship between size and performance measure collection, suggesting that larger MPOs are using performance measures more. Most notable is the strong positive correlation between size and measuring non-single occupancy vehicle (SOV) travel. However, for the most part, population, number of employees, or number of counties, all of which might denote size of an agency or region, do not appear to correlate highly with any use or barriers to use of performance measures. This suggests that there may be agencies of all sizes both that would serve as good best practices examples for performance-based planning, and ones that still have a long way to go with

their adoption and use of both required and potentially non-required performance measures.

The negative relationship between staff size and seeing a lack of personnel as a barrier to implementing performance-based planning, suggests that MPOs with smaller staff sizes may see this as an impediment to advancing in performance-based planning. However, there are still many large agencies who cited personnel needs, and small agencies who are implementing the use of performance measures robustly and early on. Case study interviews (discussed in further depth in the next chapter) revealed that agencies doing exemplary work in performance-based transportation planning with large staff and teams dedicated to performance management still feel that a lack of personnel is a barrier to not doing more earlier. It is also possible that some larger agencies do not have dedicated staff, and smaller agencies have invested more in training staff on performance-based planning. The data presented in this study do not reveal whether it is pure volume of personnel that matters, or if there could also be a problem of lacking personnel with the appropriate expertise, or certain agency or staff structures that are not conducive to introducing performance measures into transportation planning. This would be in line with Kramer et al.'s 2017 findings that around 80 percent of agencies indicated the introduction of performance-based planning to have increased staff workload by only 20 percent or less. The positive correlations between agencies stating that they don't believe a data-driven approach will improve long-range planning and that factors preventing them from using quantitative data for performance-based planning include that they are unsure what data to collect how to collect data, and how to use data suggests that aversions to the use of data

may derive from a lack of knowledge, experience, or understanding of how to use data in transportation planning.

Regional differences in the correlation are not pronounced, but there are more slight positive correlations between the use of many performance measures and being located in the Northeast or West, and slight negative correlations between using various measures and being situated in the South. The correlations between the political leaning of state legislations and performance measures use, barriers, and integration with goals and prioritization is minimal.

With a basic understanding of the descriptive statistics and variable interactions, basic models to predict aspects of performance-based planning in transportation at MPOs can be built. The step-wise regression further helps to pare down the number of variables to include in regression modeling as well as in the cluster modeling. By limiting the number of variables included, irrelevant variables and highly correlated variables get excluded from the model, thus increasing the integrity of the model. The stepwise linear regression used in R uses the Akaike Information Criterion (AIC) to perform stepwise regression in both directions, both adding and removing variables to minimize the AIC which is a function of the number of parameters in the model and the maximum likelihood. Models in this section predict how many MAP-21-required variables MPOs use, whether or not agencies use voluntary performance (non-MAP-21-required) measures, and whether or not agencies collect all of the PM1 safety measures that are imminently required by MAP-21. Many models were run, and the most influential variables were parsed out from the full cleaned dataset.

Models 1, 2, and 3 show the resulting models after performing a stepwise regression on models including the variables: population, number of full time employees, number of part time employees, number of counties, state colors (legislative political party control), collection of all MAP-21-required measures, collection of voluntary measures, and all barriers to using performance measures. Many models including barrier dummy variables showed collinearity errors, so while including just one of the barrier dummy variables eliminates the problem, it does mean that only one barrier variable can be present in each model. The most significant variable was chosen for all models. Since the population size variable is on a much larger scale than the dummy variables, the coefficients computed for it were too low to show up with a reasonable number of significant digits. For example, when Model 1 was first developed, the coefficient for population when using the bins as indicated directly from survey results gave a coefficient of 3.715e-06 (See appendix D). Creating dummy variables to indicate large and small size MPOs with a cut off of a population of 200,000 helped to resolve this issue. 200,000 people makes sense as the dividing line between small and large MPOS as it is also the threshold for designating a region as a Transportation Management Area (TMA) (49 U.S.C. 5303(k)). The model in Table 11 (Model 1) predicts the collection of MAP-21-required performance measures.

Table 11 - Model 1: Linear Regression for MAP-21-Required Performance Measures Adoption

	Num_Of_MAP21_PMs_Collected
MPO_Population_Small	-3.438***
	(0.878)
State_Color_Blue	-1.677*
	(0.941)
Voluntary_PM_Collected_Binary	2.561***
	(0.930)
Barrier_Personnel	1.698*
	(0.892)
Constant	9.205***
	(0.899)
N	183
R^2	0.143
Adjusted R^2	0.124
Residual Std. Error	5.457 (df = 178)
F Statistic	7.428*** (df = 4; 178)
Note:	***p < .01; **p < .05; *p < .1

Model 1 shows population size, state legislature political control, whether or not an agency collects voluntary performance measures, and agency identification of personnel as a barrier to using performance measures as the best descriptors of how many MAP-21-required performance measures an MPO uses. The statistical significance of the constant in Model 1 was present in all models run on the available data. This shows that there are variables not present in the data set that may be helpful in developing models to predict the use of performance measures at MPOs, which could also help explain more than the 12.4 percent of the data that the adjusted R^2 of Model 1 shows can be explained with what is given. Model 1 shows that the size of an agency and whether or not they choose to use

performance measures that are not required are the most significant predictors of how many required performance measures an agency chooses to use. MPOs in regions with under 200,000 people are less likely to already be using MAP-21-required measures, and agencies that are collecting voluntary measure are more likely to be doing so. Additionally, MPOs located in states with democratically controlled state legislature (State_Color_Blue) are collecting fewer MAP-21-required measures. The most statistically significant barrier to using required performance measures is a lack of personnel, but this variable acts in the opposite direction than expected in the model. Agencies noting personnel as a barrier are collecting more required performance measures. It is possible that once an agency begins actively using the MAP-21-required measures, they notice that they could be doing even more with more staff. Figure 19 shows the residual plots for Model 1.

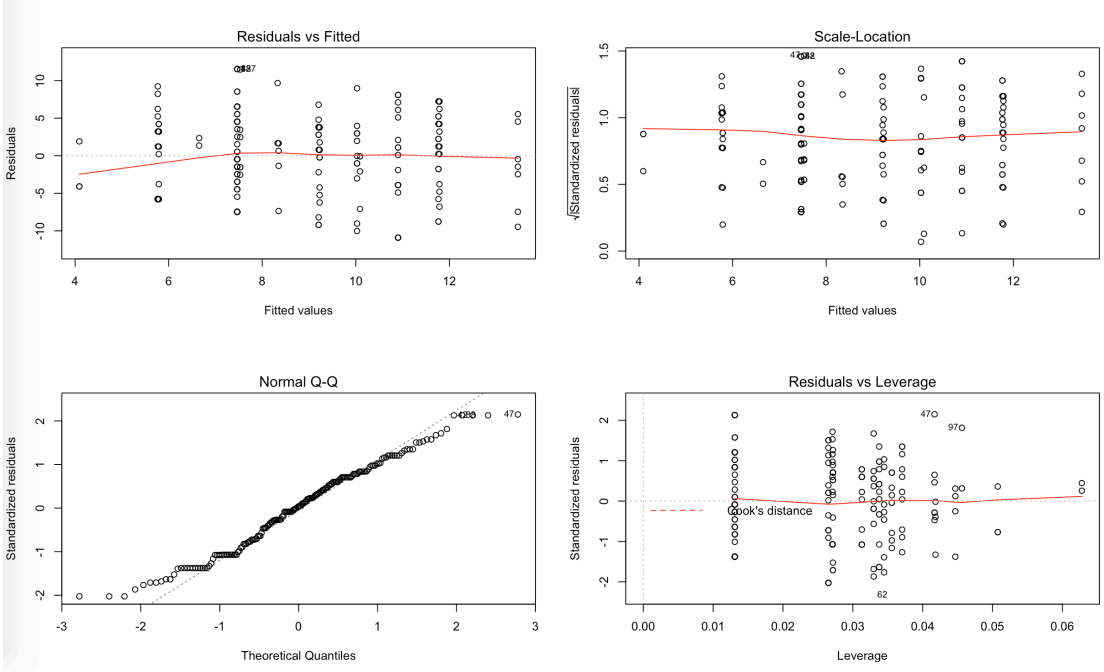


Figure 19 - Model 1 Residual Plots

An examination of the residual plots associated with Model 1 shows that although the variables in the model are all dummy variables and thus do not give a model for continuous distributions, they have reasonable distributions to use them in a linear regression model. The plot in the upper left corner that shows the residuals versus the fitted values has an evenly scattered distribution as does the plot of the square root of the standardized residuals versus the fitted values demonstrating homoscedasticity. The normal Q-Q plot shows that while there are a few outliers, the residuals are pretty normally distributed. The outliers are not concerning and are left in the regression because each agency is an important part of the model and the residuals versus leverage plot shows that no single case has a particularly strong influence on the model results. The lack of additional bounding Cook's distance lines in the plots shows that all cases are well within the bounds of having outlier residuals.

Table 12 shows Model 2, a logistic regression predicting the binary variable of whether or not an MPO indicated using voluntary performance measures in their survey response. Model 2 was also developed using stepwise regression and minimizes the AIC.

Table 12 - Model 2: Linear Regression for Voluntary Measure Adoption

	Voluntary_PM_Collected_Binary
MPO_Population_Small	-0.133**
	(0.066)
Num_Of_MAP21_PMs_Collected	0.011*
	(0.006)
Geographic_Region_South	-0.167**
	(0.065)
Agencies_did_Peer_Review	0.124*
	(0.067)
Barrier_Dont_Beleive_In_Data	0.195**
	(0.092)
Constant	0.238***
	(0.091)
N	183
Log Likelihood	-97.642
AIC	207.284
Note:	***p < .01; **p < .05; *p < .1

The calculated McFadden's pseudo R^2 for Model 2 is 0.15, which suggests that the model is a fairly good fit for the data. While the political control of state legislature showed up in Model 1 and geographic region did not, Model 2 includes geographic region but no political control. Whether or not an MPO reviewed peer agency practices can indicate the use of voluntary performance measures, but not the MAP-21-require measures.

Since many agencies have not yet adopted the MAP-21-required measures in PM2 and PM3, and the due dates for target setting and reporting of those measures is farther in the future than PM1, it would also make sense to look use the adoption of the PM1 measures (safety measures) instead of all MAP-21 measures. Model 3 replaces the MAP21All variable with the binary variable of Collected_All_Safety which indicates whether or not an agency has adopted all the required safety performance measures.

Table 13 - Model 3: Logistic Regression for Binary Safety Performance Measures Use

	Collected_All_Safety
MPO_Population_Small	0.109*
	(0.057)
Num_Of_MAP21_PMs_Collected	0.062***
	(0.005)
Barrier_Dont_Beleive_In_Data	0.160*
	(0.090)
Barrier_Politics	-0.140**
	(0.068)
Constant	-0.105
	(0.067)
N	183
Log Likelihood	-73.828
AIC	157.655
Note:	***p < .01; **p < .05; *p < .1

McFadden pseudo R^2 of 0.88 is very high and the AIC is low, but there are few variables in the model and there is likely high collinearity between variables. A Chi square test of Collected_All_Safety and Num_Of_MAP21_PMs_Collected confirms a relationship between the two with a highly statistically p-value of 1.014e-11. Removing the number of MAP-21-required variables from Model 3 does not leave a statistically significant model

option. A model with all the other variables from Model 3 is shown in Model 4 in Table 14.

Table 14 - Model 4: Alternative Logistic Regression for Binary Safety Performance Measures Use

	Collected_All_Safety
MPO_Population_Small	-0.105
	(0.075)
Barrier_Dont_Beleive_In_Data	0.082
	(0.123)
Barrier_Politics	-0.030
	(0.093)
Constant	0.532***
	(0.061)
N	183
Log Likelihood	-132.269
AIC	272.538
Note:	***p < .01; **p < .05; *p < .1

When the number of MAP-21-required variables is removed from the model, the rest of the independent variables no longer show up as significant and the AIC shoots up. Part of the problem with developing a model to predict whether or not MPOs have adopted all of the safety measures from PM1 is that so few agencies (only 87) have done so. Narrowing down safety to only one measure also did not provide useful model results. Various models were built to model MPO participation in the performance area of safety using the most widely used variable of total number of fatalities as a surrogate for safety. Both manually developed logistic regression models including and excluding various variables and stepwise regression models run in R show that the number of fatalities cannot be explained well with the available data from this survey, suggesting that further data about

characteristics or practices of MPOs could improve the model, or that there simply is no good model to predict what agencies are measuring number of fatalities.

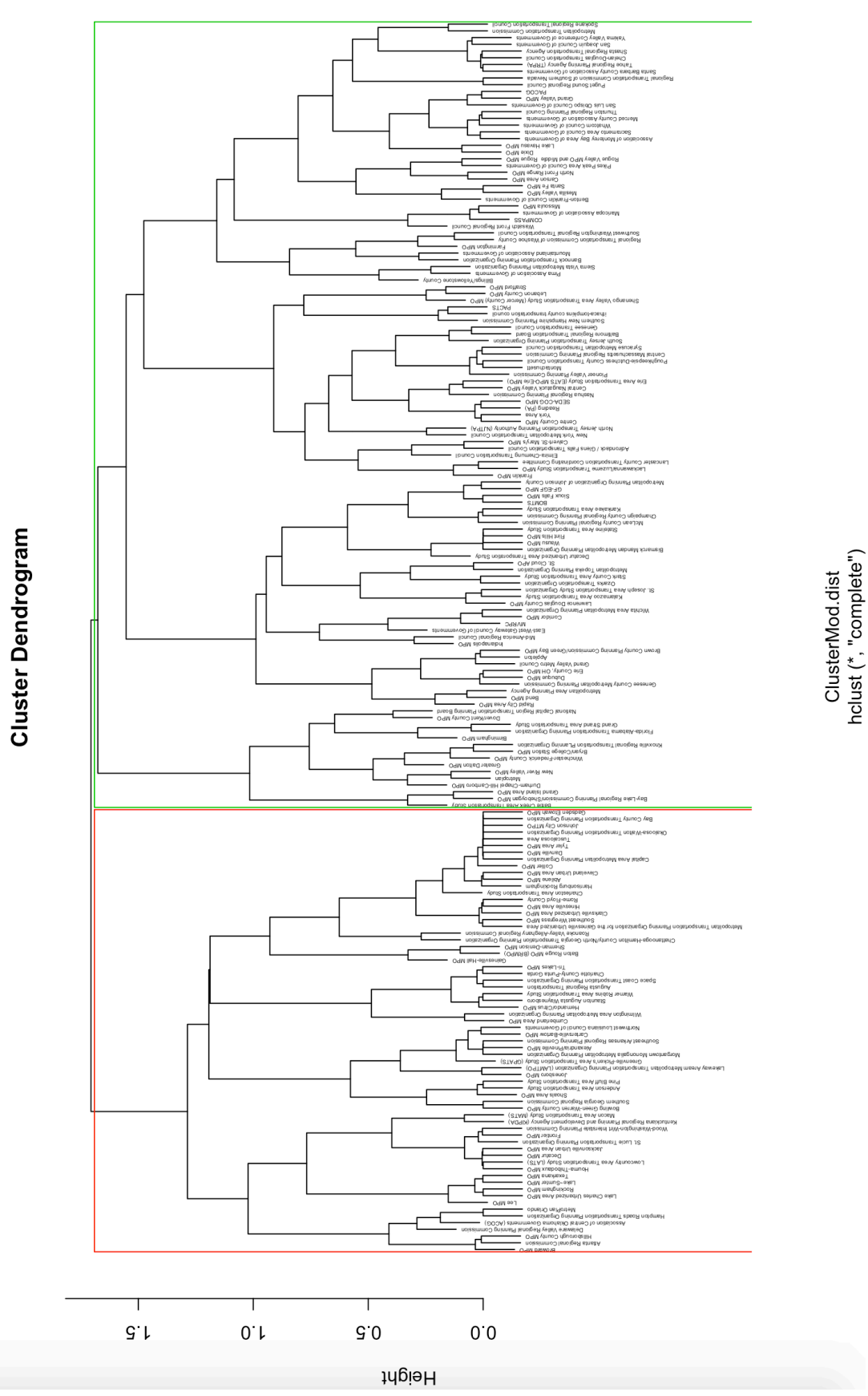
The fact that it is so difficult to build a model to predict safety performance measure adoption suggests that the available data collected from this survey in early 2017 cannot predict to any level which agencies are likely to have adopted the PM1 requirements. Since it is possible to build a model to predict the number of MAP-21-required measures, examining which agencies have adopted all measures could also be an interesting model with predictive powers. A model could also be built to examine specific performance areas such as safety, freight, or environmental sustainability.

4.5.3 Cluster Analysis

The purpose of conducting a cluster analysis is to observe connections and trends among agencies by grouping them by regional/agency characteristics, and performance-based planning practices and barriers. Cluster analysis is a good model to use when variables are correlated with each other, such as in the data set in this study as the analysis groups these variables together to avoid inflated statistics indicating statistical significance. The cluster analysis also serves as a cohort analysis for the federal government to see what types of agencies are adapting more easily or in different ways to Map-21 rules and general executive and legislative goals of moving towards performance-based transportation planning.

The hierarchical cluster analysis conducted uses complete agglomerative methods to pull clusters together maximizing the distance between clusters. Many cluster analyses were examined, but only two are presented in this document. The correlation matrix and

regression helped to inform which variables to use in cluster analysis of the data to see what types of agencies are in similar stages of their adoption of MAP-21 requirements, their overall state of the practice in performance-based planning, and what barriers they see as holding them back. The variables chosen for the first cluster analysis presented include began using variables significant in the linear regression models. Figure 20 shows the model-based cluster dendogram that included the variables for regional population, state legislative political party control, geographic region, whether the MPO reviewed peer agencies, politics as a barrier, a lack of belief in data-driven methods as a barrier, the number of MAP-21-required variables collected, and whether or not voluntary measures were collected. The two-cluster solution is shows on the dendogram with red, and green outlines.


Cluster Dendrogram
ClusterMod.dist
hclust (*, "complete")
Height
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0.5
1.0
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Figure 20 - Cluster Dendogram With Model-Informed Variables: Two Cluster Outline

The cluster sizes are fairly balanced, with groups of 66 and 117 agencies. As the heights indicate the remainder of the correlation coefficient (height = 1- correlation coefficient), the dendogram shows a lack of distance between the two clusters. The model was broken into two clusters based on evaluation of various graphical and numeric tests.

Plotting the within-cluster sum of square in an elbow plot graphically indicates how many clusters a data set might best break into. A break, or sharp corner in the plot indicates a where the data might best naturally cluster. Figure 21shows the elbow plot for the cluster analysis using model variables.

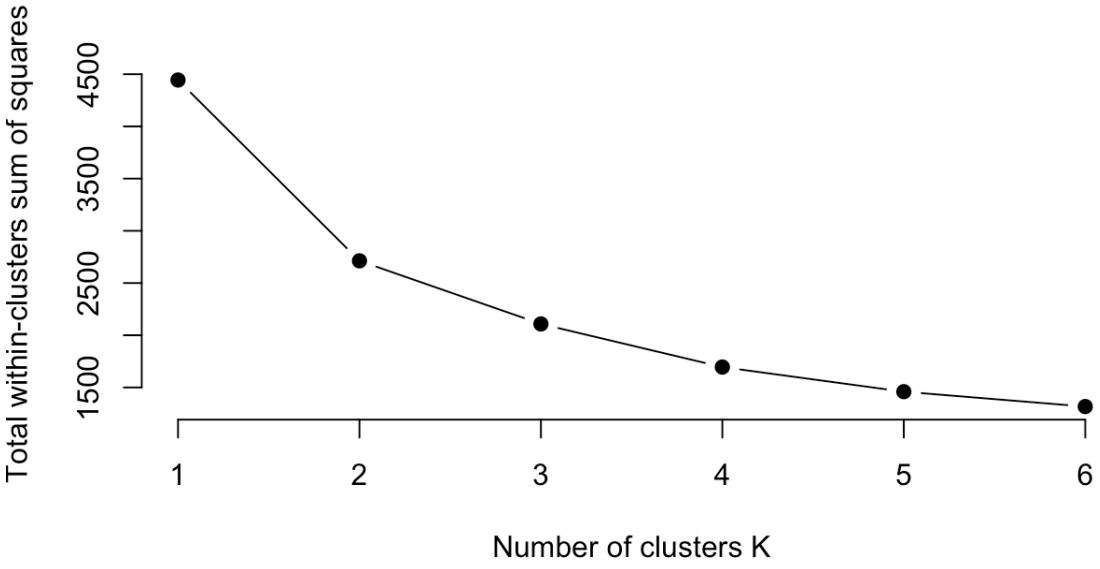


Figure 21 - Elbow Plot for Cluster Analysis with Model-Informed Variables

Figure 21 suggests that two clusters is likely the best solution as the sum of squares for three or more clusters create a smooth shallow curve. The within cluster sum of squares as well and the and the average distance between clusters is shown in Table 15.

Table 15 - Two and Three Cluster Solution Statistics: Model Variables

	Calinski-Harabasz index	Within-cluster sum of squares	Average distance between clusters
2 cluster solution	72.41	73.40	1.17
3 cluster solution	58.09	62.46	1.16

The Calinski-Harabasz (C-H) index for the two-group analysis is 72.41, much higher, and therefore preferable, to the 3 cluster solution C-H index. The average distance between clusters is only slightly higher for the two-cluster solution at 1.17 compared to 1.16. The plots in Figure 22 show the two and three cluster solutions for the data next to each other.

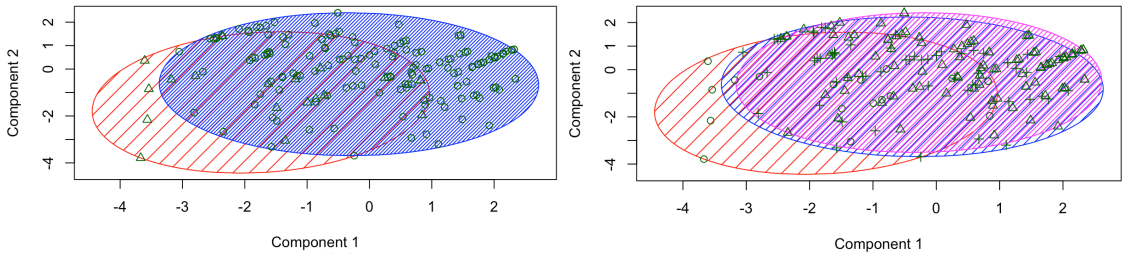


Figure 22 - Cluster Plots for Three- and Two-Group Cluster Analysis with Model-Informed Variables

Figure 22 graphically shows the proximity of two of the clusters in two dimensions as explained by the first two components of a principle component analysis. The analysis explains about 36% of the variation in the data. The characteristics of each cluster (Group 1 and Group 2) in the two-cluster solution are shown in Table 16.

Table 16 - Group Characteristics for Two-Group Cluster Analysis with Model-Informed Variables: Characteristic Variables

	Population (means of population size groups)				State Political Leaning (-1: red, 0:purple, 1:blue)				Peer Review Conducted (0 "no", 1 "yes")			
Group	mean	median	max	min	mean	median	max	min	mean	median	max	min
1	401,136	150,000	>1 million	50,000-99,999	-0.91	-1	1	-1	0.41	0	1	0
2	475,000	350,000	>1 million	50,000-99,999	-0.17	-1	1	-1	0.67	1	1	0

Table 15 shows the main characteristic differences between the groups with Group 2 leaning slightly larger, slightly more democratic, and with more group members who review practices at peer agencies. Additionally, not shown in Table 16, Group 1 contained all of the MPOs in Southern states, while Group 2 contained all of the MPOs in the Midwest, Northeast, and West, suggesting the geographic region is a main contributor to the cluster divisions. No agencies in Group 1 identified a lack of belief in data as a barrier, while some in Group 2 did, and members of both groups identified politics as a barrier. Table 17 shows the differences in the use of performance measures in Group 1 and Group 2.

Table 17 - Group Characteristics for Two-Group Cluster Analysis with Model-Informed Variables: Performance Measure Variables

	Number MAP-21 Measures (Number of required PMs adopted)				Voluntary Measures (0 "no", 1 "yes")			
Group	mean	median	max	min	mean	median	max	min
1	7.73	7	19	0	0.15	0	1	0
2	9.24	10	19	0	0.36	0	1	0

Table 16 shows the skew towards high usage of both voluntary and required measures in Group 2, which generally includes larger agencies and none of the southern MPOs.

A more robust cluster analysis includes all of the variables in the data set – not just those maintained in the regression models. The cluster analysis shown in the dendogram in Figure 23, and expanded upon in the subsequent tables and figures, includes variables describing characteristics, the use of each individual MAP-21-required performance measure, the use of specific voluntary performance measure areas, identified barriers to using performance measures, and the incorporation of performance measures in regional and state goals, objectives, and prioritization methods.

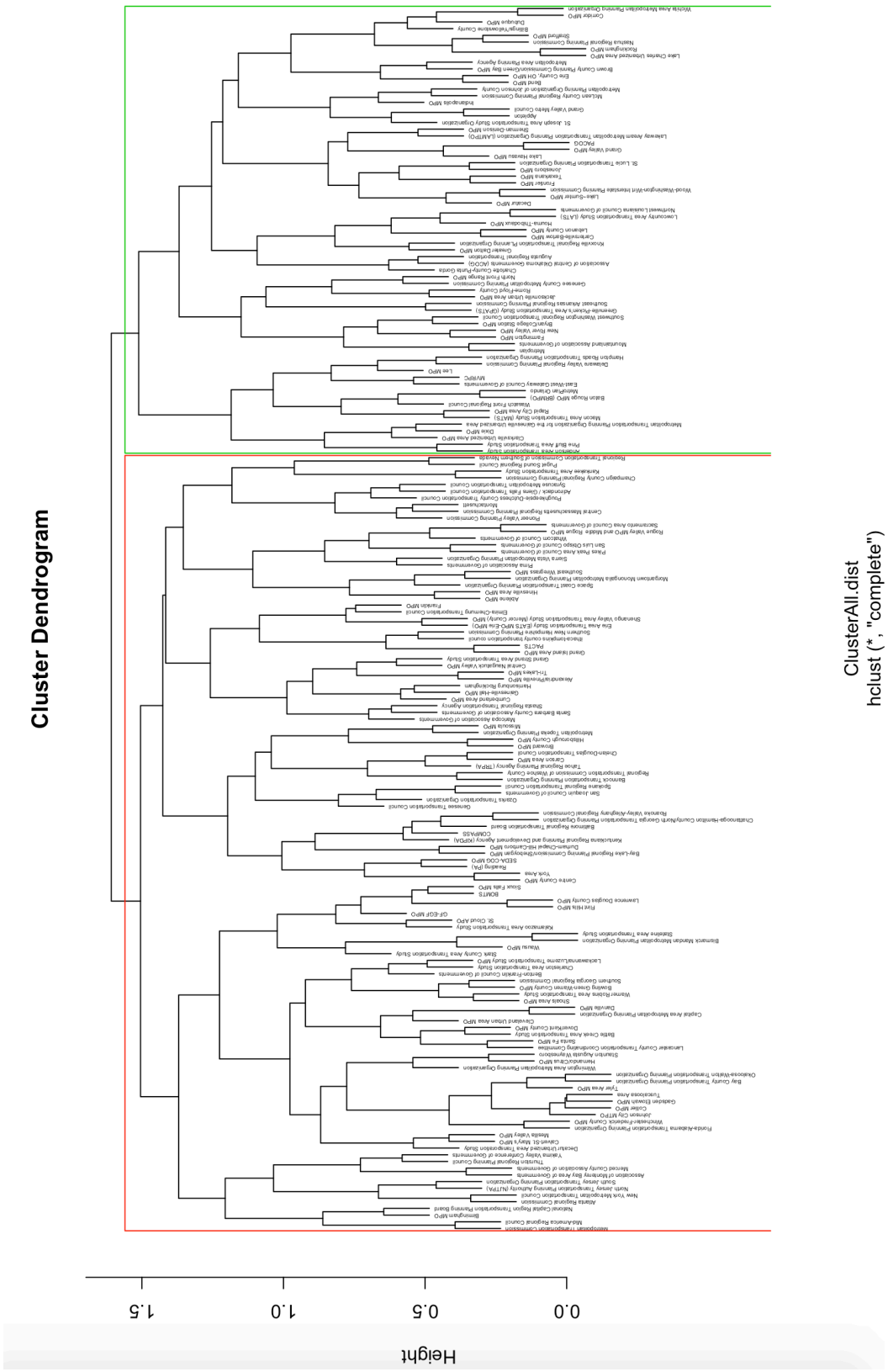

Cluster Dendrogram
ClusterAll.dist
hclust (*, "complete")
Height
0.0
0.5
1.0
1.5

Figure 23 - Cluster Dendogram With Model-Informed Variables: Two Cluster Outline

Again, a two-cluster solution was chosen based on analysis of the model. An elbow chart (Figure 24), and the C-H index (Table 18) justify the two cluster solution.

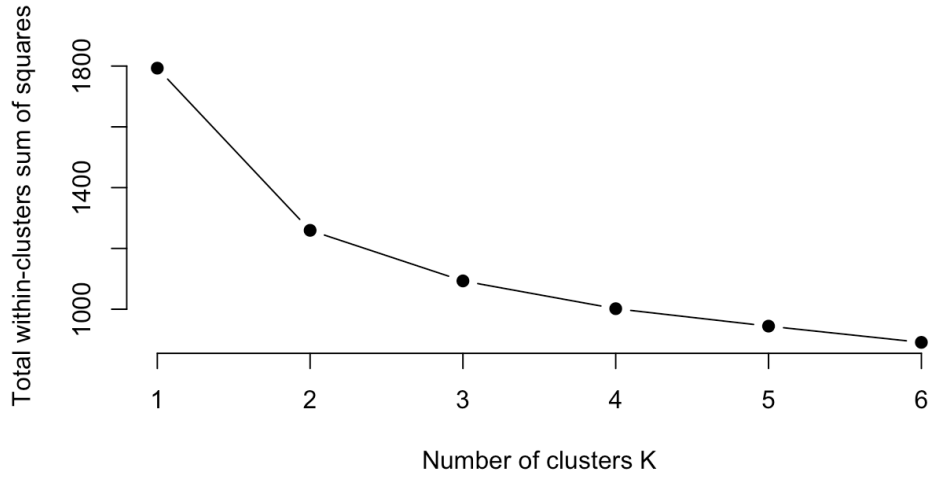


Figure 24- Elbow Plot for Cluster Analysis with Model-Informed Variables

Table 18 - Two and Three Cluster Solution Statistics: All Variables

	Calinski-Harabasz index	Within-cluster sum of squares	Average distance between clusters
2 cluster solution	19.77	92.65	1.05
3 cluster solution	11.02	91.56	1.04

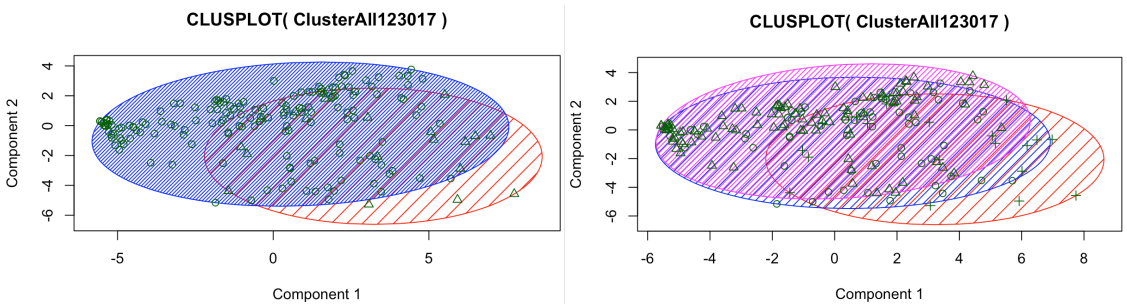


Figure 25 - Cluster Plots for Three- and Two-Group Cluster Analysis with All Variables

The cluster plots in Figure 25 compare the two- and three- cluster solutions. The first two components from a principal component analysis explain about 31% of the data in both solutions, which suggests that there is a slightly less well-fit model than the cluster analysis presented for the model-selected variables which explains just over 36% of the data.

Group 1 includes all of the agencies that indicated collecting freight measures and all of the agencies that indicated collecting accessibility measure. All other performance measure collection carriers across both groups. Group 1 also has a higher percentage of agencies that collect transit-, bicycle-, emissions-, and pedestrian- related voluntary performance measures. The split seems to be along the lines of more likely to collect required versus more likely to collect voluntary measures, and agencies in Group 2 are more likely to collect the MAP-21-required measures. The largest differences between the means for required groups are in the bridge/pavement (PM2) and reliable travel time (part of PM3). Group 2 has a slightly higher mean for all variables indicating MPOs linking performance measures to both regional and state goals, objectives, and prioritization methods.

Geographically, Group 1 skews Northeast and West, while Group 2 skews South and Midwest, which not surprisingly corresponds to a redder mean in Group 2 and bluer in Group 1, from a political perspective. There is very little difference in the barriers to using performance measures identified by the agencies in each group, and very little difference in size, both in terms of regional population, the number of counties, and the staff sizes.

4.6 Survey Discussion

Given that PM1 was the first rulemaking published and that safety has long been a priority in transportation planning and decision-making the low levels of adoption by early 2017 of the required measures indicates that many MPOs are barely keeping up with the FHWA timeline. The even lower levels of adoption of PM2 and PM3 measures corroborate this. Low levels of adoption led to difficulties in model building, and regression models with the survey data cannot explain more than around ten percent of the data. Even with low adoption levels of the requirements so far, many respondents noted in the comments that the list of required measures from USDOT is lacking, specifically in multi-modal areas with little emphasis on transit, bicycling and walking. Even though the use of bicycling and walking measures were among the highest use types of voluntary performance measures, there is still a perceived and actual lack of data and performance-based planning in these areas.

Further exploration of individual measures or performance areas could lead to additional statistically significant models, especially by converting performance area data collection in to binary variables and aggregating the collection of individual performance measures within one performance area. The example of the use of safety measures in a

logistic regression shows the difficulty in building a model to explain performance measure use. This may also be due to the fact that there are just very few patterns in agency characteristics and planning practices that can help predict the use of performance-based planning in transportation at MPOs.

The models for the use of MAP-21-required measures and voluntary measures suggest that examining performance-based planning by agency size may be relevant, but is not a large predictor in how many measures an agency has adopted. The data analysis and models also both show that agencies who list certain barriers, specifically a lack of personal and a lack of belief in using data-driven approaches for long-range transportation planning correlate with agencies that are more likely to be implementing the use of performance measures. This could be because agencies don't identify the barrier until the process is underway. The identified barriers suggest that policy-related guidance, especially relating to how to communicate with certain types of states legislatures or transportation agencies, or how to deal with boards or peer agencies who do not believe that a data-driven approach will benefit transportation planning at a regional level, might be useful, especially once agencies ramp up their use of performance measures.

The large number of agencies citing a lack of resources as a barrier to conducting performance-based planning suggests that providing dedicated funding for personnel, training, software, data collection, or other areas may help agencies feel that they have the capacity to incorporate performance into their transportation planning. Further training on what data could be useful and how to collect it as well as highlighting opportunities for agencies to share data from local transit agencies, state DOTs, or other agencies or coalitions could also aid in creating more widespread adoption of performance measures.

Even though some respondents claimed that their agencies struggled with conducting performance-based planning due to a skepticism of using a data-driven approach in planning, many of them adopted performance measures (both mandated and not) anyway. Even though many of these agencies listed this as the weakest barrier, it suggests that a skepticism of data-driven approaches can be overcome. Creating legislative mandates could be a major factor in pushing performance measurement forward at these agencies.

Mixed responses in comments sections from MPOs indicated reasons that some agencies are still behind in adopting MAP-21 requirements. Some MPOs simply state that January of 2017 was too early to be thinking about using performance measures as none of the requirements fully came into effect until later in the year, and that was still only very few requirements. Meanwhile, some respondents indicated the opposite, that the impending deadlines were very soon and though they were indeed beginning to collect and use data, the timeline seemed very short and requirement deadlines were quickly approaching.

Reviewing practices at other MPOs, or state DOTs predicted the use of voluntary performance measures in a logistic regression model. Part of the purpose of the case study chapter in this dissertation is to provide best-practice examples with full discussion of the internal process and publicly available documents at different types of agencies who began adopting the use of performance measures early and often. Though reviewing practices at peer agencies is not a predictor of how many MAP-21-required measures MPOs are using, that is not to say that it wouldn't also be valuable. Further analysis examining connections between peer learning and linking measures and goals may also provide insight to what lessons could be learned.

A cluster analysis based on only the characteristic variables suggested broke up agencies very differently than the two cluster analyses presented in this chapter. The dendogram for the characteristic-based cluster analysis can be found in Appendix E. The agencies chosen for the case studies are in mostly different groups in a four-cluster solution, with the Atlanta, GA and Baltimore, MD in group 4, Pocatello, ID in group 3, and Louisville, KY in Group 1. Groups 1 and 4 were generally larger by both regional population and number of employees, Group 2 skewed blue, while groups 1, 3, and 4 skewed red. In the Model-based cluster analysis, Baltimore and Pocatello both fall into Group 2, Atlanta and Louisville into 1. This array of characteristics and practices amongst the four chose case study agencies, as well as indications from all of in their survey responses that they heavily use both required and voluntary performance measures, provides four unique best-practices examples in the next chapter.

CHAPTER 5. CASE STUDIES

Even before MAP-21 passed in 2012, Metropolitan Planning Organizations knew that performance measure requirements were on the horizon. Some agencies saw this as an opportunity to get ahead of the curve and begin discussions amongst staff, boards, and working groups, and developing documentation and practices to incorporate performance measures. The future was vague though, and without any notices of proposed rules from the USDOT until 2014, performance-based planning at MPOs, when present, was guided by factors other than the federal requirements. Agencies utilized various strategies to guide their foray into formal incorporation of performance measures and target setting.

The goal of the case studies presented in this section is to provide best practice examples of agencies of varying size and geopolitical situations. Synthesizing publicly available documents and conversations with agency staff provides insight into agency motivations, approaches, and setbacks. Case studies include agencies identified in distinct clusters in the survey data cluster analysis to increase distance between characteristic and agency practice variables. Each case study delves into the process behind the decision-making, current practice, and future of performance-based planning at each agency.

The studies, which include the metropolitan regions for Atlanta, GA; Baltimore, MD; Louisville, KY; and Pocatello, ID, identify current and best practices at MPOs of different size and geopolitical situations. For each case study, the performance-based planning framework from Figure 2 has been adapted based on the agency's planning process and structure. The frameworks identify the strongest contributors to performance-based planning at each agency and thus do not include all the elements that the agency

takes into account. For example, all agencies utilize resources from their state DOTs, but this element only shows up in the frameworks for the agencies where state DOT involvement is a strong influencer of their current performance-based planning practices. Interviews and conversations with staff as well as analysis and evaluation of planning documents paint a picture of how performance measures and targets can be used by MPOs to improve prioritization, implementation, and evaluation of transportation projects. The studies identify best practices as well as recommendations for improvements in effective and efficient planning processes.

5.1 Previous Case Studies on Performance-Based Planning at MPOs

As part of their Measuring What We Value study, Transportation for America (T4A) completed case studies examining data-driven decision-making in the context of health for Sacramento, CA, Broward County, FL, Nashville, TN, Greensboro NC, and Las Cruces, NM. The case studies examined for this dissertation do not overlap and include a more varied geographic scope.

The T4A Study of Las Cruces, NM shows that while the region faces many challenges that may be expected of a small MPO (population just over 100,000 people), they have focused on bolstering community engagement among historically underserved population groups which has led to community input having more weight on project prioritization. (Transportation For America, 2016a). Neither the case study nor further investigation into the current planning process at the Mesilla Valley MPO indicate a use of quantitative measures either derived from public engagement nor by other means.

Spurred by an element of MAP-21, various transportation alternative (TA) grant opportunities are consolidated into the Transportation Alternatives Program (TAP). TAP changed only vary slightly and congress renamed it the Surface Transportation Block Grant fund under the FAST Act in 2015 (FHWA, 2017). The Greensboro, NC MPO aligned goals and objectives for bicycle and pedestrian projects with NCDOT and FHWA TAP program priorities showing the effectiveness of tying additional funds to state and national initiatives to guide actions of MPOs (Transportation For America, 2016b).

Of the five T4A case studies, only the Sacramento and Nashville studies mentioned quantitative metrics associated with their planning strategy. Nashville MPO recorded miles of bicycle and pedestrian infrastructure built, and estimated public health outcomes of number of people affected by specific chronic diseases (Transportation For America, 2016c), and the Sacramento Area Council of Governments (SACOG) listed their priorities as general targets for performance outcomes including VMT, transit rider and active transportation counts, and other, broader goals with a total of 20 performance measures identified and tied to seven goals. SACOG also pointedly noted the distinction between developing performance measures that are feasibly useful on a network level compared to a project level, and that they might not always overlap (Transportation For America, 2016d). Broward County MPO measured how many localities adopted Complete Streets policies (Transportation For America, 2016e). The Broward County MPO measure is an example of the need to be careful about what performance measures and outcomes to track, as Complete Streets, bicycling, and walking advocacy groups, have recently expressed concern that adoption of Complete Streets Policies does not necessary correlate with

measures more directly related to transportation agency goals of safety, environmental benefits, and others as policy adoption is not always followed by implementation.

5.2 Case Study Overview and Methods

Exploratory research talking with regional transportation planners and engineers began in 2015 in Atlanta and continued with staff from agencies across the country at conferences and meetings. Talking with staff from various agencies at various stages in their adjustments to MAP-21 requirements helped to inform the survey instrument and following case studies. MPO staff repeatedly acknowledged a desire for best practices and examples in how other agencies were adapting to the new legislation and regulations.

In the fall of 2017, four case studies were conducted through in-depth review of agency policies, plans, and documents and interviews with agency staff directly responsible for leading the performance management and performance analysis for the regional transportation planning. The four case study MPOs cover a range of size, geographic regions, political climates and fall into different clusters in the MPO groupings identified in the survey analysis of this study. All of the selected case study agencies completed the full survey, indicated a heavy use of both MAP-21 mandated and voluntary performance measures, and agreed to follow-up discussions. The case studies are, 1) The Atlanta Regional Commission (ARC) in Atlanta, GA; 2) Baltimore Metropolitan Council (BMC) in Baltimore, MD; 3) Kentuckiana Regional Planning and Development Agency (KIPDA) in Louiseville, KY and IN; and 4) Bannock Transportation Planning Organization (BTPO) in Pocatello, ID.

The interviews with MPO staff included discussing timing, reasons, and methodologies behind adopting aspects of performance based-planning; influences of and attitudes towards MAP-21 and the associated requirements; target setting; and intra- and inter-agency coordination. The questions asked to each agency included topics covering:

- Who at the agency began thinking about and implementing performance-based planning, and why and how they did so, including specifics about performance measures and target setting
- The influence of MAP-21 on the agency's transportation planning
- The relationship between the MPO, the state DOT, transit agencies, advocacy groups, the general public or any other group/organization as related to data collection or performance measure use in transportation planning
- Constraints faced by the agency

In person interviews were conducted with the Atlanta Regional Commission in Atlanta and the Baltimore Metropolitan Council in Baltimore. Interviews with the Kentuckiana Regional Planning and Development Agency and Bannock Transportation Organization were performed via phone. All information in the case study section is directly from interviews with staff at each respective agency unless otherwise cited.

5.3 Atlanta Region, GA

Agency	Atlanta Regional Commission (ARC)
Population	4.4 million
Number of counties	22
Number of staff	25 full time, 1 part time
Geographic Region	South
State legislature	Red
Most recent long-range plan (RTP)	2016, revised 2017
RTP horizon year	2040
MAP-21 Measures used	All
Voluntary PM Performance Areas	Mobility & Congestion, Reliability, Network Connectivity, Multimodalism, Asset Management & Resiliency, Safety, Air Quality & Climate Change, Environmental Sustainability, Cultural & Environmental Resources, Social Equity, Land Use Compatibility, Goods Movement, Employment Accessibility

Planners interviewed at the Atlanta Regional Commission included members of the performance monitoring and analysis team and planners who work in specific transportation modes. One interview was conducted in January, 2015, and the second one in December, 2017. Both interviews were conducted in-person at the ARC headquarters.

5.3.1 Development of Performance-Based Planning

The ARC began thinking about and applying performance-based planning into their transportation planning in some way since before the current institutional can pinpoint. Formal incorporation of performance measures in the long-range transportation plan (RTP) may have begun just before 2003, when the RTP, titled Mobility 2030 included performance measures with a particular focus on air quality and congestion. The next RTP Envision6, expanded the focus on performance to include a more multi-modal perspective and tie in land use, while still focusing on measures for air quality, and congestion/delay. Even as early as 2000, ARC introduced systematic, periodic reporting for the 2025 Land

Use Strategy, only the agency did not include transportation performances areas, just development patterns, population, housing, and employment growth (White & Smith, and Parsons Brinckerhoff, 2010). Much has changed since the 2025 plan, and ARC emphasizes that they continuously update methodologies for deciding on and using performance measures. While Envision6 focused largely on highway performance and projects, the 2040 Atlanta Region's Plan focuses heavily on livability.

One tool used when assessing performance-based practices is to examine what other metropolitan areas are doing. As discussed in the previous chapter, 105 agencies out of the 183 MPO survey respondents indicated that they reviewed practices at peer agencies to inform their use of performance measures in transportation. ARC staff find reviewing best practices at other MPOs and guidance from FHWA useful not only to inform their own planning practices, but also a means to validate their overall approach of backing up decision-making with data-driven planning. Staff also identified the Transportation Research Board as a valuable organization to help agencies transition under the MAP-21 requirements. When presenting performance-based planning and data-driven planning initiatives to leadership in the agency including higher up staff and board members, noting recommendations from FHWA or identified use of a technique as a best practice at another agency adds muster to the recommendation and provides additional support to adopting a practice. ARC listed eight MPOs as examples they have looked it in the context of performance-based planning:

- San Diego Association of Governments (SANDAG)
- North Central Texas Council of Governments (NCTCOG)
- Southern California Association of Governments (SCAG)

- The San Francisco region Metropolitan Transportation Commission (MTC)
- New York Metropolitan Transportation Council (NYMTC)
- Delaware Valley Regional Planning Commission (DVPRC)
- Denver Regional Council of Governments (DRCOG)

All of the peer agencies reviewed are large MPOs, but geography and politics vary across the examples to which the ARC turned.

By the time the USDOT issued PM1, PM2, and PM3 rulemakings, ARC had already been using performance measures equivalent to those required for quite some time, as well as many additional measures not included in the federal requirements. Most notably, ARC has a much more multi-modal array of performance measures.

5.3.2 Performance Areas and Performance-Based Planning Framework

ARC silos transportation planning by mode, and the comprehensive multi-modal performance areas and evaluation criteria as well as the weighting methodology in the Transportation Improvement Program (TIP) are new. The TIP currently under development will be the first time the agency creates a project prioritization framework off of performance measures. Projects are compared within categories of roads and highways, transit, and bicycles and pedestrians. The agency views projects geared towards mobility by different modes as fundamentally different. Each modal group has different goals, and thus differences in the weighting for the performances measures that are used to rank projects. This allows the ARC to compare "apples to apples and not apples to oranges" (D'Onofrio, 2017). To reflect the preference for multimodal projects, the prioritization system also includes a multi-modal performance measure associated with each project type

to allow for extra points for projects that incorporate more than a single mode. The modal silo approach works under the assumption that projects are primarily geared towards one specific mode, and that projects oriented towards different modes have different goals, leading to different measurable aspects varying in importance. With many sources of federal and state funding dedicated to certain modes, prioritizing projects by mode also maintains consistency in prioritization methods within funding sources (D'Onofrio, 2017). For non-dedicated funding, the ARC must decide to what area they wish to assign funds. The upcoming federal infrastructure spending plan take an opposite approach, grouping all infrastructure together including all modes of transportation, broadband, and various other areas of infrastructure (Gardner, 2017). Depending on the specifics of the spending authorization, this could free up more funding opportunities that various modes of transportation projects would be eligible for which would loosen ties between funding sources and goals.

Losing a direct connection between spending and stated goals is less problematic if an agency is measuring progress towards their goals to hold themselves accountable for the funding decisions they make. The ARC develops the short range fiscally-constrained TIP in tying it back to the regional goals stated in the RTP. Each performance measure used has specific performance metrics with clear inputs and variable typologies. Each measure also fits into one of the state performance areas, which is directly tied to a long-range goal for the Atlanta region as developed in the RTP. In this way, all data being collected and used for project prioritization ties directly to regional goals and short-term assessment as required in MAP-21 can allow the ARC to evaluate the effectiveness of projects in the TIP according to the long-range plan framework. Table 19 shows an example of how the

bicycle, pedestrian, and multi-modal trail performance measures all tie back to goals in the Atlanta Region's Plan.

Table 19 - Relationship between Regional Goals and Bicycle and Pedestrian Performance Measures at ARC.

Source: ARC, 2017b

Atlanta Region's Plan Goal	Performance Area	Performance Measures		
		Bicycle	Pedestrian	Trail
	Mobility & Congestion	No. of bicycle trips generated	No. of pedestrian trips generated	No. of pedestrian & bicycle trips generated
	Reliability			
	Network Connectivity	Transit accessibility; bike network accessibility	Transit accessibility; pedestrian network accessibility	Transit accessibility; trail network accessibility
	Multimodalism	Multimodal Accommodations		
	Asset Management & Resiliency			
	Safety	Improved safety (Serious injury + fatality crashes; bicycling crash risk; safety countermeasures proposed)	Improved safety (Serious injury + fatality crashes; walking crash risk; safety countermeasures proposed)	Improved safety
	Air Quality & Climate Change	Project emissions (Change in NOx, VOC, & PM2.5 emissions; Change in greenhouse gas emissions CO_2)		
	Environmental Sustainability			
	Cultural & Environmental Resources	Benefits to Cultural and Environmental Resources		Impact on Culturally & Environmentally Sensitive Land Uses
	Social Equity	Addressing Social Equity (Does the project serve an ETA community?)		
	Land Use Compatibility	Connections to High Density Propensity Areas (Project connect to high density propensity areas?)		Expanding Regional Trails; connections to Parks
	Goods Movement			
	Employment Accessibility	Supporting Regionally Significant Locations (Project connect to/within a Regional Employment Center, a Freight Cluster Area or a Regional Place?)		

The data needed for each of these performance measures are readily available from the MPO or GDOT. Some of the measures come from modeling, such as air quality assessment, while most are real-world data. Beyond active transportation measures, many of ARCs voluntary measures use the same data as what is required for MAP-21 requirements but that express the data in a different way. For example, ARC uses average travel time as a congestion performance measure that will harness the same travel time data as the MAP-21 required measure of the percent of a system providing for reliable travel times. These are data and models that the ARC has been implementing for years.

One impetus to incorporate performance in both long- and short-range planning came from Atlanta's non-attainment status in the 1990s and early 2000s. Obligation of federal funds due to air quality non-attainment gave the ARC a monetary incentive to measure current and future performance to evaluate projects and programs intended to improve air quality both to qualify for funding again, and to be able to assess those projects and programs to be confident in their ability to achieve attainment in upcoming years and confidently program federal transportation dollars (D'Onofrio and Kim, 2017; White & Smith, and Parsons Brinckerhoff, 2010). This cycle of assessing current conditions to develop visions and decide on performance measures has served the agency well in areas beyond air quality assessment. The general framework for Atlanta's performance-based planning process is shown in Figure 26.

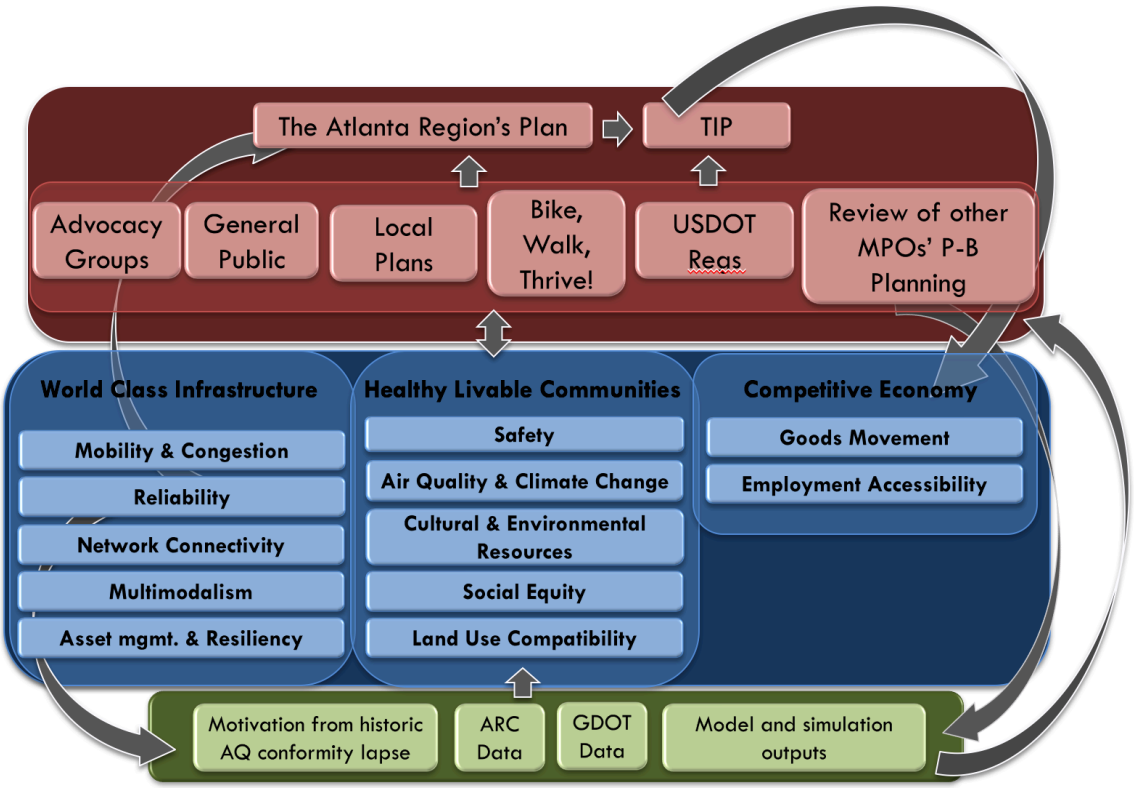


Figure 26 - Atlanta Regional Commission Performance-Based Planning Framework

The ARC performance-based planning framework includes many feedback loops indicating evaluation of the state of the region and the relationships between the visions in long-range plans, short-term fiscally constrained plans, project prioritization, performance areas, the data and modeling inputs as well as coordination with various local and regional groups.

Although the ARC is one of the leading MPOs in the country in efficient use of performance-based transportation planning practices, they still acknowledge that they could be doing even more and adapting and evolving measures and priorities more quickly if they had more staff dedicated to performance management. There can also be disconnected priorities between different levels of staff and board members, but this does

not stand in the way of implementing good planning practices as ARC is a collaborative agency that is accustomed to implementing change more than other MPOs across the country. The requirements under MAP-21 helped staff to communicate the importance of using performance-based planning, especially in the TIP (which is relatively new), by allowing them to simply cite that the methods are a federal requirement, which supports the process along with the reasoning of quantitative analysis and increased accountability.

5.3.3 Target Setting

The MAP-21 deadline for states to set targets for the safety performance measures (PM1) was August 31, 2017, and the MPO deadline is set for February 27, 2018. As the regulation places the duty of target setting first to the state, and later to MPOs, coordination between the two is generally left up to the initiative of states and regions agencies. In Georgia, the state DOT set targets on a date pushing the deadline that the MPOs will all adopt. Similar to other MPOs who already have well-established performance-based planning practices, ARD will re-develop targets to fit a more urban and regionally specific context in the future. Setting unique targets for the MPO will also allow the ARC to tie the targets directly to regional visions and goals.

The ARC performance team believes in taking time to develop and constantly adjust performance measures and targets over time. This will keep the performance-based planning relevant both for long-range goals and short-term project prioritization in the TIP. Maintaining accountability to the public is important, and the structure developed by congress and the USDOT provides a useful framework for MPOs to increase accountability and transparency to the public, the state DOT, and the USDOT.

5.4 Baltimore Region, MD

Agency	Baltimore Regional Transportation Board (BRTB)
Population	2,797,407
Number of counties	6
Number of staff	30 full time, 4 part time
Geographic Region	South
State legislature	Blue
Most recent long-range plan (RTP)	2015
RTP horizon year	2040
MAP-21 Measures used	10 out of 19
Voluntary PM Measure Areas	Accessibility, bicycle, pedestrian, freight

Long-range planning staff at the Baltimore Metropolitan Commission (BMC) were interviewed in person in Baltimore both at the beginning and end of 2017.

5.4.1 Development of Performance-Based Planning

The Baltimore Regional Transportation Board (BRTB) began developing performance measures and targets in early 2011 in anticipation of MAP-21, for the 2035 long-range transportation plan, Plan It 2035. Plan It 2035 included performance measures, but did not establish targets (BRTB, 2011). The establishment of the Plan It 2035 measures gave the next long-range plan a base to build from, and they did add many measures in the next RTP. The agency hoped to stay ahead of the rule-making to provide ample time to think out the incorporation of measures and targets in their planning process and to be able to incorporate the measures and targets in the 2014-2015 development of the Maximize 2040 long-range plan. BRTB prioritized including all the anticipated required performance areas into Maximize 2040 over waiting for proposed and final rulemaking from the USDOT. In anticipation, staff reviewed American Associate of State Highway and Transportation Officials (AASHTO) recommendations, with the assumption that since

USDOT had closely followed AASHTO recommendations for the PM1 NPRM, they were likely to follow recommendations for PM2 and PM3. BRTB also reviewed practices at peer agencies which included agencies that used measures both in the MAP-21 performance areas discussed by AASHTO and in other voluntary areas such as accessibility and land use. Providing the board with examples of major US cities making strides in performance management such as San Francisco and Chicago, Baltimore Regional Commission (BMC) MPO staff were easily about to explain to the board that moving forward early and going above and beyond expected requirements with performance measurement was a good idea. Communication with the board also benefitted from overlap of persons serving both on the board and on advisory committee.

5.4.2 Performance Areas and Performance-Based Planning Framework

Standing committees helped guide and inform BMC staff throughout the process of performance measurement development and connections between the measures and the 2040 long-range plan. Committees foci corresponded to goals with topical areas including bicycles and pedestrians, safety, freight, etc., and they were formed to advise and interface with the MPO in the transportation planning process. The standing committees reviewed practices and documents from other MPOs and the Maryland Department of Transportation (MDOT) Attainment Report (which incorporates the use of performance measures and ties them to goals) for examples of measures to use and how to incorporate them into the planning process. Internally, the Congestion Management Report, which address performance monitoring of measures relating to volume/capacity, travel time, and access to transportation systems and to jobs, also served as an example and starting point. Figure 27 shows the performance-based planning framework for BRTB.

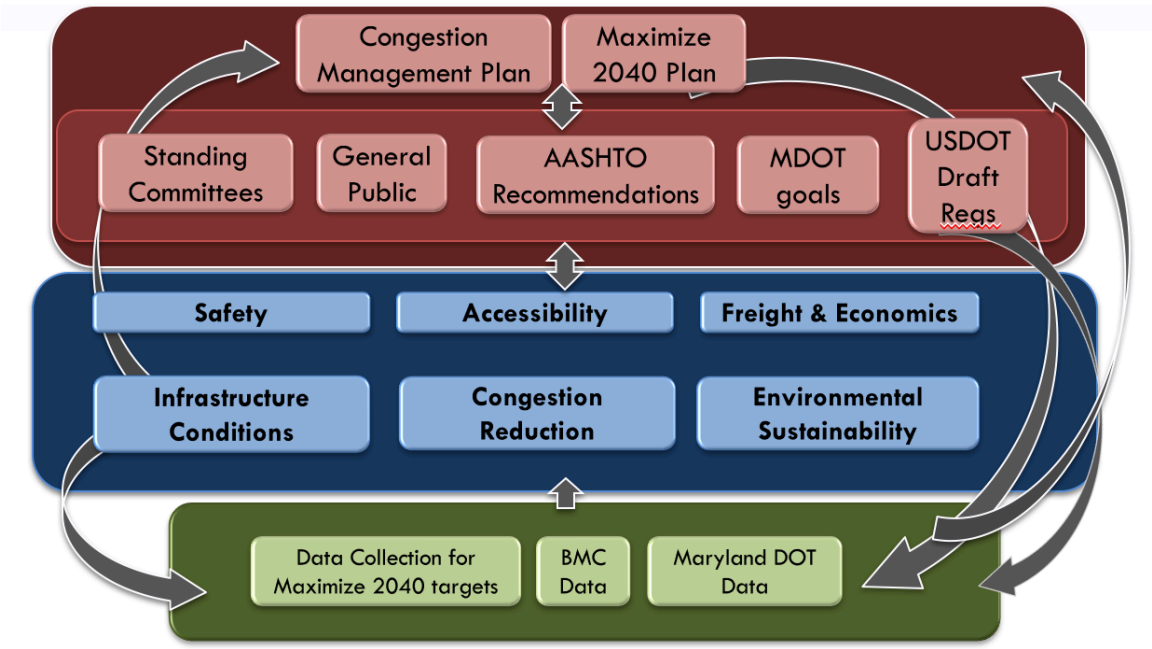


Figure 27 - Baltimore Regional Transportation Board Performance-Based Planning Framework

BRTB did not intend to limit their choices of performance measures to use based on data availability, but did find that acquiring the data needed to track some of their chosen measures presented a challenge. Using the MDOT Attainment report and AASHTO and DOT documents as a base for choosing measures was beneficial in ending up with measures that relied on data that was already available through national reporting or the state DOT. The data sharing needs increased coordination between the MPO and the State DOT. While the MPO used to have to ask well in advance for specific data to run inquiries for specific counties or localities in the region, the establishment of standard, periodic reporting under MAP-21 has promoted increased communication. A large factor in increasing capacity to connect MPO and state efforts and resources is the shifting of duties for state staff. The State Highway Administration (SHA) has assigned a staff member to dedicate time specifically to performance measures and targets. This gives the MPO a

clear point of contact who has time and knowledge in the area. In a shift of responsibility and leadership in performance-based planning, instead of BMC staff contacting the date, the SHA staff member now reaches out to the MPO as each USDOT rulemaking passes.

Plan It 2035 linked performances measures to goals by listing out the measures for each goal. The plan indicated the transportation modes each measure applied to, but did not specifically organize performance measurement by mode like ARC does. Maximize 2040 defines performance areas that each measure fits into and each area directly relates to a regional goal. Table 20 shows each performance area identified in Maximize 2040 and the measures and goals tied to them.

Table 20 - Relationship Between Regional Goals and Performance Measures at the Baltimore Regional Transportation Board

Maximize 2040 Goal	Performance Area	Performance Measures
Increase safety for all users	Safety	No. of roadway injuries, no. of roadway fatalities
Emphasize preservation of existing system; promote efficient system management and operation	Infrastructure Conditions	% miles acceptable quality roads, % structurally sound bridges, avg. age of busses
Increase accessibility and mobility for people	Congestion Reduction	% VMT in congestion
Support metro economic vitality; increase accessibility and mobility for freight	Freight & Economics	Truck turnaround time
Increase accessibility and mobility for people	Accessibility	% roads w/ sidewalks, % bike/walk to work mode share, Avg. # daily transit riders
Protect and enhance the environment	Environmental Sustainability	levels of NOC, NO_X, $PM_{2.5}$, CO

Just one of the goals stated in the plan do not have a performance area tied to them, "to increase security for all transportation users." Security is, however, addressed in the criteria that BMC uses to evaluate and prioritize projects in the long-range plan. Along

with accessibility, the goal of security does not relate directly to MAP-21 performance areas. The BMC reviews performance measures and targets periodically and monitors performance over time on an annual basis to maintain an evolving and dynamic approach to performance measurement.

For the time being, BRTB has adopted the SHA developed targets required for the safety measures in PM1. However, the agency does plan to develop regionally specific targets over time. Although BRTB does not emphasize strategies in target setting as specifically as the Kentuckiana Regional Planning and Development Agency (KIPDA), they do note the importance of setting targets that are both realistic and attainable. Setting both long- and short-term targets help to be able to achieve this goal. MDOT has already established a long-term goal working towards zero deaths on roadways. One benchmark target is to cut roadway fatalities in half by 2030. The MPO adjusted this long-term goal for their own jurisdiction to aim for zero roadway fatalities by 2040. By consistently monitoring performance and using five-year rolling averages for analysis, the agency sees target setting as an ever-changing activity for the agency staff and board.

5.4.3 Target Setting

The most assertive involvement in performance measure and target development to date has come from the bicycle and pedestrian community. Each advisory committee included advocates in the related field, including the bicycle and pedestrian committee. The minimal attention to active transportation from the federal requirement also opened up ample space for the committee to interject ideas. The BMC staff saw their enthusiasm as a positive addition, and indicated good communication between staff and the committee

when the committee would set forth ideas for measures with ambitious data needs or targets and conversation would bring them to more achievable plans.

While short-range targets are being set as required by the USDOT, BRTB has not gotten to the point of incorporating performance measures in the TIP. The TIP flows directly from the state Consolidated Transportation Program (CTP). The BRTB does plan to use performance-based planning measures in the TIP in the future, and are using the goals, performance areas, measures, and targets identified in existing documents including Maximize 2040 as a starting point for the next iteration of the RTP. As USDOT publishes the final rules for PM2 and PM3, they will also be adopted into the RTP if they have not been already.

MAP-21 spurred increased attention and resources devoted to performance-based transportation planning at both regional and state agencies, which improved data sharing, communication and collaboration, and pushed agencies to move forward in developing performance measures and tying them to regional goals. Using previously developed internal documents and other MPO plans and documents as a starting point for incorporation of performance measures helped to inform the process at BRTB which will continue to evolve.

5.5 Louisville Region, KY and IN

Agency	Kentuckiana Regional Planning and Development Agency (KIPDA)
Population	947,150
Number of counties	5
Number of staff	18
Geographic Region	Midwest
State legislature	Red (two state)
Most recent long-range plan (RTP)	2015
RTP horizon year	2035
MAP-21 Measures used	14 out of 19
Voluntary PM Measure Areas	Accessibility to transit, bicycle, pedestrian

A phone interview was conducted with five members of the Kentuckiana Regional Planning and Development Agency (KIPDA) staff in late 2017. Staff members included leaders in the transportation division including transportation planners and GIS specialists.

5.5.1 Development of Performance-Based Planning

Over the past 25 years Kentuckiana Regional Planning and Development Agency (KIPDA) staff have discussed the possibility of introducing performance measures into transportation planning, but little traction was ever gained due to the data collection and analysis needs and difficulties associated with implementing a process that fully reflected the needs and wants of the region to the satisfaction of the planning partners in the area. Over the years some looked at the performance-based planning approach as beneficial for working towards regional goals by tying performance into project prioritization, others preferred to focus on individual project outcomes at a local level without context within the larger transportation network. MAP-21 spurred the agency to move from talk to action to incorporate performance measures into their planning process.

The 2035 long-range Metropolitan Transportation Plan (MTP), Horizon 2035, does not address the use of performance measures, but the 2040 MTP will, and the agency is well into developing the new plan (KIPDA, 2014). In between the 2035 and 2040 MTPs KIPDA developed and published a Performance Management Plan (PMP), which directly informs the new long-range pan (KIPDA, 2015). Another element of the 2040 MTP developing included high levels of engagement from policy and advisory committees. MPO staff were very pleased with involvement and engagement of committees, and worked with them to adjust suggested measures and targets to realistically match data availability and project feasibility.

5.5.2 Performance Areas and Performance-Based Planning Framework

KIPDA has the unusual (but not unique among MPOs in the United States), situation of falling across the border of more than one state. Coordination with the state(s) for data needs and target setting is integral to fulfilling the MAP-21 reporting requirements which leaves MPOs like KIPDA in a situation that calls for extra collaborative efforts. Since multiple state instances were not addressed in great detail in either the legislation or the regulations, MPO staff sought further guidance from the Federal Highway Administration Kentucky State Division to figure out how to deal with their situation and were advised to work with both states for all collaboration between MPOs and state DOTs. As both Indiana and Kentucky are states with a lot of rural areas and infrastructure, their goals not only do not necessarily align with each other in terms of magnitude and prioritization areas, but also are not directly transferable to the Louisville urban region due to the rural-urban divide. With the current timeframe for target development, KIPDA will continue to conduct their regional planning using the measures and targets that relate to

their regional goals, and will coordinate with both Indiana and Kentucky to adopt both states' measures for now. The MPO plans to work closely with both state DOTs and the regional transit agency moving forward to strive for a situation where the agencies can connect goals, objectives, and targets to not end up in a scenario with three separeate targets for each uniform standard performance measure in the future: one for each state and one for the MPO. Figure 28 shows the framework for performance-based transportation planning at KIPDA.

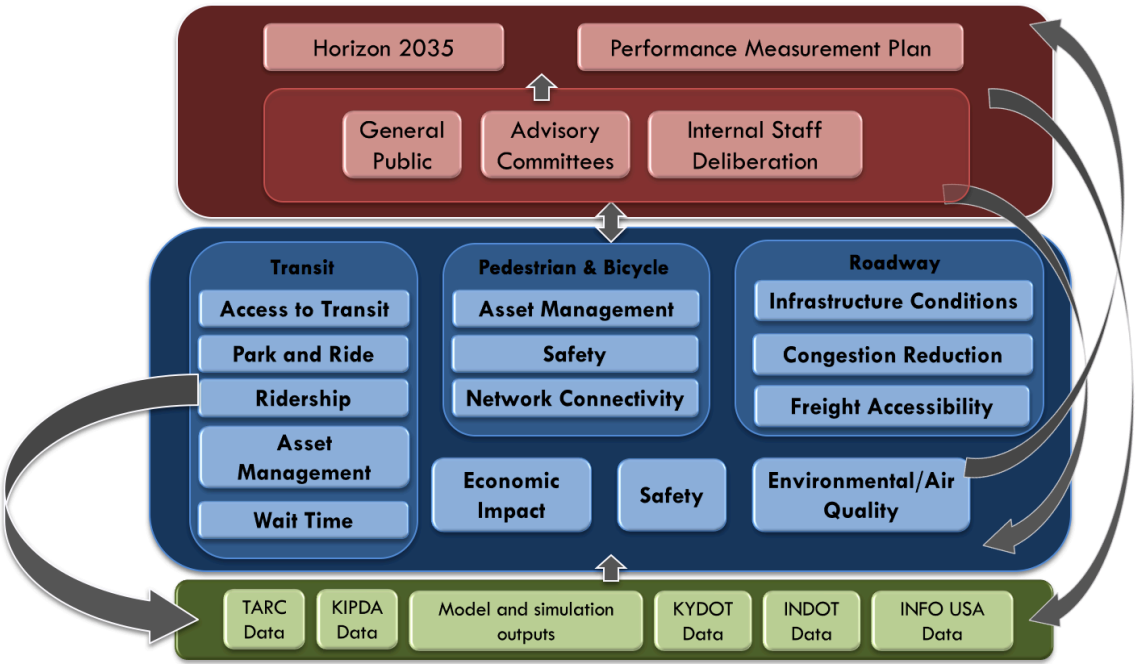


Figure 28 - Kentuckiana Regional Planning and Development Agency Performance-Based Planning Framework

In the current 2015-2035 MTP, KIPDA did not directly link the goals and objects stated in the PMP and the MTP with the performance measures used in a table like the ARC, but does discuss both in the same context. They also don't identify distinct performance areas, but do separate performance measures by mode, similar to the ARC methodology, and

identify areas that transcend modes such as safety and the environment. Performance measures within each mode fit into some of the general performance areas, but also include some more mode-specific areas which are included in Figure 28.

Existing conditions data acquisition and management are especially challenging for multi-state MPOs as they not only have to coordinating with more state DOTs, but also need to combine data into the same format to be able to use it. Especially when developing additional regional performance measures, this extra challenge means that the MPO, with some performance measures, is limited to state DOT data that can be combined and compared with the other state DOT data in order to create a comprehensive database. The agency also relies on the states for some MAP-21 required measure data, though states should recognize the need for this given the mandates. The regional transit agency, the Transit Authority of River City (TARC) also provides data to the MPO through an increasing level of collaboration between the two agencies, which is due in part to newly incorporated performance-based planning practices. KIPDA also looks beyond transportation agencies for useful data. While KYTC does not currently collect serious injury data usable by KIPDA, the MPO is still able to acquire data Kentucky State Police. And data sharing network with the state police, state DOT, and MPO allows access to the data that is not publicly available. Since accessibility and connectivity for alternative transportation is important to the agency, the MPO purchases employment data from InfoUSA to examine access and connectivity to jobs and conditions within employment cluster areas.

5.5.3 Target Setting

The 2015 PMP sets targets for 2020 and 2025. The staff intentionally developed specific, measurable achievable, relevant, and time-bound (SMART) targets to help keep themselves accountable. While some MPOs began developing performance measures even long before the MAP-21 rulemaking came out, KIPDA was ahead of the game on setting regional SMART targets. However, because the USDOT had not yet established them they were unaware at the time what the timeframes for reporting would be. In the next version of the PMP which is currently underway, the agency plans to set both long-range targets for its upcoming MTP and short-range targets for federal reporting. Similar to Bannock Transportation Planning Organization, KIPDA sees the short-term targets as limiting, even using five-year rolling averages, as some measures yield such small numbers that statistical significance in changes over time will be hard to decipher over just two to four years. The next PMP will build upon the current document, maintaining and modifying the KIPDA developed measures and adding the federally required measures, many of which also contribute to the agency stated goals.

The other setback to target setting that KIPDA faced in 2015 that they have resolved for the next iteration of performance planning was a lack of some baseline conditions. Especially in the areas of bicycle and pedestrian facilities, the agency had incomplete knowledge of the current inventory and set measures and target using estimates and trying to set conservative targets to keep them achievable. Since the 2015 PMP, staff have inventoried bicycle lanes and sidewalks and gathered additional data from localities and state DOTs to prepare for more informed target setting.

KIPDA sees the biggest hurdles in implementing performance-based transportation planning in data collection and analysis. Challenges lie in having enough staff to update

the volumes of exiting data while moving forward to collect new data needed, and acquiring the expertise needed to use the data analysis software (especially for processing of big data, which is entirely new to the agency). With the long wait for PM 1 requirement and a short transition time to then implement PM 2 and PM3 agencies need to ramp up data management quickly. MPO staff believe that they are doing a good job evolving, learning, and staying on top performance management, and that the challenges they are facing will become easier to overcome over time as they adjust to new practices.

Besides the challenges of coordinating with two states that leads to managing multiple sets of goals and data formats, KIPDA differs from the other three case studies presented in their development of performance-based transportation planning without turning to outside examples. The agency began work on the PMP early on, looked around to see if other MPOs had publicly available documentation on their own performance measure use practices but did not find useful examples. The introduction of the use of performance measures resulted from mostly internal ideas and discussion which has continued on in the creation of their 2040 long-range plan. KIPDA staff sees the PMP as a living document that will continue to evolve.

5.6 Pocatello Region, ID

Agency	Bannock Transportation Planning Organization (BTPO)
Population	77,400
Number of counties	1
Number of staff	1 full time, 1 part time
Geographic Region	West
State legislature	Red
Most recent long-range plan (RTP)	2015
RTP horizon year	2040
MAP-21 Measures used	10 out of 19
Voluntary PM Measure Areas	Bicycle, pedestrian, land use, system accessibility, public involvement

A phone interview was conducted with the Executive Director and only staff member of the Bannock Transportation Planning Organization (BTPO) at the end of 2017.

5.6.1 Development of Performance-Based Planning

BTPO began measuring performance around 2010 when their long-range plan included service standards with condition targets for facility availability, level of service, and accessibility. The service standards included a select few performance measures and targets for highways, transit, and bicycle and pedestrian facilities (BTPO, 2010). The introduction of performance measures came about amid national discussions around performance requirements for transportation planning and the BTPO believed in the theory behind the approach. Staff saw the value in measuring achievements to tie implementation to visions and goals. This paradigm shifted away from previous long-range planning efforts that would sometimes adjust goals to reflect achievements instead of adjusting prioritization of future projects to achieve previously stated goals. The use of performance

measures allowed the agency to evaluate transportation planning strategies and increase transparency with the public.

5.6.2 Performance Areas and Performance-Based Planning Framework

In the 2035 LRTP the agency's main focus in performance measurement centered around asset management, but has diversified since then and is now a multi-modal performance management system for the movement of both people and goods. Figure 29 shows the performance-based planning framework BTPO.

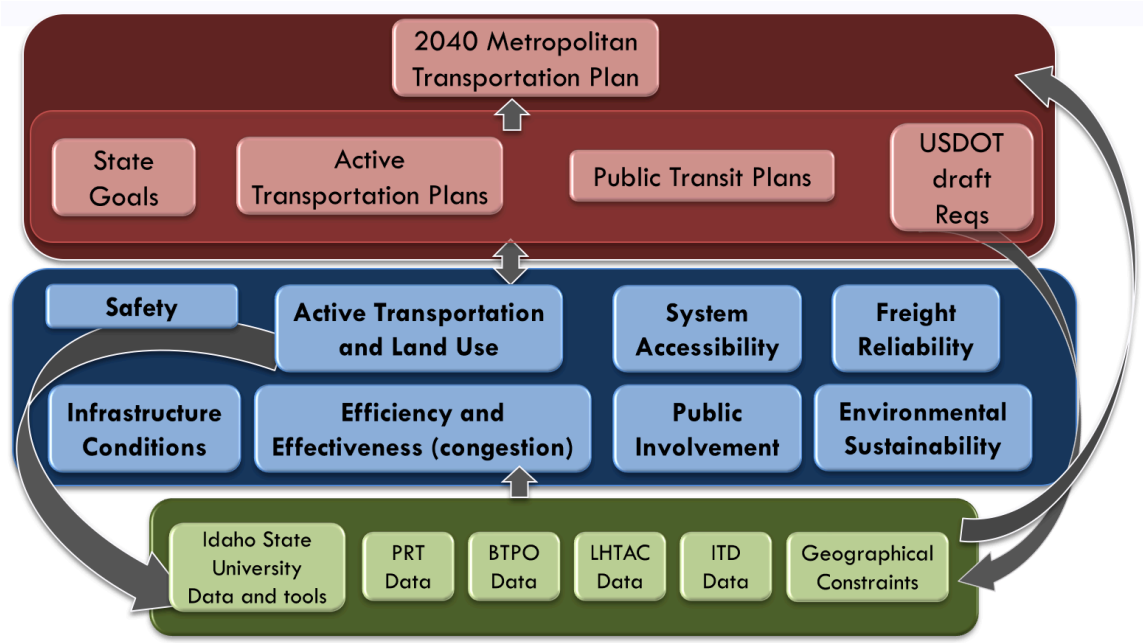


Figure 29 - Bannock Transportation Planning Organization Performance-Based Planning Framework

Voluntary performance areas identified by BTPO include public involvement, system accessibility, and active transportation. Public involvement is important to the Portneuf Valley region and assessing levels of engagement can help the MPO measure involvement over time. Effective public engagement is especially important as some regional goals do

not match up with public perception of what the agency should be prioritizing. BTPO sees providing bicycle infrastructure as a means to increase road safety and encourage mode shift since there is limited space to build additional capacity for vehicles. A lack of an active bicycle advocacy group and minimal cycling enthusiasts mean that the agency needs to dedicate resources to inform the public on the benefits of bicycle projects. Measuring the levels of engagement resulting from this investment will help the agency assess their strategies and engage with the public better in the future if necessary. Some of the measures that the MPO is using are merely to fulfill federal requirements, but are not actually useful to the agency. Measuring performance on national highway system roadways does not help the MPO understand or plan for traffic conditions unless they measure performance on all arterials in the region and assess performance of a different set of roadways.

The BTPO uses data from a variety of sources including the local transit system, Pocatello Regional Transit (PRT), the state DOT (ITD), the state agency Local Highway Technical Assistance Council (LHTAC), and commute mode share data from the American Community Survey. The agency also benefits from efforts out of the Idaho State University (ISU), located in Pocatello, ID in the BTPO region which encompasses the Portneuf Valley. Beyond the available data and tools, the real-world situation of the geography strongly affects transportation and land use planning in the region. Geographic constraints of a valley with steep slopes rising on the side and surrounding lands all under federal jurisdiction means that horizontal expansion is just not a possibility for the Bannock County area.

Due to land area constraints and a growing population, congestion management is a top priority for the region. However, given that BTPO does not have power of land use management and does not have land use data over time to control for land use changes. BTPO staff question the usefulness of tracking congestion over time without requirements or the ability to track and control land use changes over time as the two are clearly interlinked and depend on one another. Land use management is an important element of congestion management and can account for changes in congestion and travel times which is important to understanding the transportation system.

BTPO uses scenario planning to forecast the future of transportation in the Portneuf Valley which plays a large role in the regional long-range transportation plan. The scenario planning utilizes data from the various sources available and the RTP ties MAP-21 planning factors to regional goals which informs the staff's identification of a preferred scenario. Scenario planning is just part of the overall process used to create and revise each RTP. The components and cyclical process of the RTP is show in Figure 30.

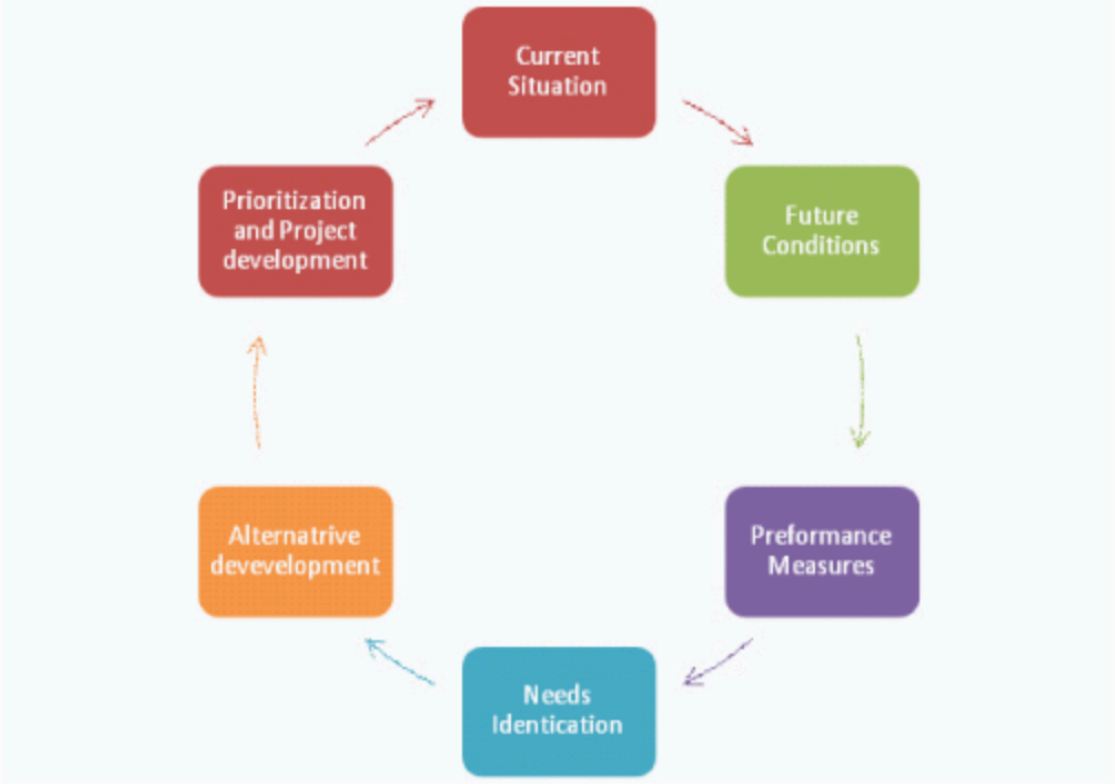


Figure 30 - Bannock Transportation Planning Organization Regional Transportation Plan Components

Source: BTPO, 2017

The use of performance measures is an equal building block in the plan development informed by current and future conditions and leading to needs identification and scenario development that informs project prioritization. The agency board consists of elected officials and is in agreement with the 2010 shift to performance-based planning. Since the approach is mandatory and the board approves the vision and goals of the MPO, specific measures being used or elements of the planning process do not concern board members allowing for autonomy of the staff to fit performance areas with regional goals.

5.6.3 Target Setting

BTPO plans to adopt statewide targets for the MAP-21 required measures, but has also begun thinking about how to set targets for the voluntary regional measures. The MPO staff believes that IDT is situated to set reasonable and effective targets, and there is one MPO representative involved in the statewide strategic plan, from which the performance targets will flow directly. One representative for MPOs from the entire state is still limited regional input, and the difference for targets on a state and major metro-region scale compared to smaller urbanized areas such as Bannock county are notable. On the smaller scale of a region with a population of under a 100,000 people, some performance areas end up measuring events on such a small scale that statistical significance in measurements of change over time is challenging. When only three roadway fatalities are recorded in a year, a percent or absolute number reduction in fatalities may be achievable over long periods of time, but year-to-year could reflect variables that are unrelated to or not under the purview of the MPO. The unique aspects of small urban regions motivated the BTPO to develop their own regional targets in the future to incorporate them into the long-range plan.

MAP-21 spurred BPTO to begin tracking data needs, examining data sources, and thinking about target setting. The MPO also saw the connection between performance management and transparency both to the public and within the agency. The single staff member recognized the need to document the methodology behind performance measure development and use both for future agency staff and the general public. The Performance Measures Methodology Report allows for methodological updates and a full documented history of the use of performance measures at the agency (BTPO, 2016). Much like at KIPDA, the BTPO staff believes strongly in constantly changing and updating performance measures as current conditions and future goals change, and now update the

Performance Measures Methodology Report annually and are working on incorporating it into the TIP.

The biggest constraints to incorporating performance measures into transportation planning identified by BPTO staff were personnel and time. The staff size of one at the agency limits the ability of the MPO to synthesis and utilize data. Fulfilling MAP-21 reporting requirements is not a huge burden since the data are available and a performance-based planning methodology is now established. This highlights the difference between utilizing the requirements to change transportation planning practices and merely going through the exercise of compiling data and reporting to USDOT. Small MPO staff members, such as at the BPTO, believe that ultimately it is left up to the small MPOs as to whether they make the MAP-21 requirements useful or not. Bringing the idea to agencies is a first step, and then the MPO can choose to intentionally utilize and tweak the measures to fit their goals and needs over time.

5.7 Case Study Synthesis and Discussion

All of the case study regions emphasized the importance of coordination with and learning from either local, state, or peer agencies suggesting that dissemination of knowledge can help MPOs move forward in performance-based transportation planning. Each relationship with the state was different, but all also noticed the difference in priorities for states, who have large portions or rural jurisdictions, and MPOs, who are dealing solely with urban regions. Framing performance measures within performance areas or modal silos, especially looking beyond the areas of PM1, PM2, and PM3 identified by the USDOT seems to help MPOs connect measures to regional goals. Additional documentation such

as specific plans based on performance measurement also helped to communicate with agency boards and committees, the general public, and current and future MPO staff to set a current state of the practice for the use of performance measures and encourage ongoing adaptation and adjustments of measures and targets.

With the survey result correlations and models from Chapter 4 suggesting that reviewing peer agencies seems to be related to how far an MPO has come in performance-based planning practices, it is not surprising that survey results showed all four case study agencies reviewing practices at other MPOs, and some of them suggest that this is an important as a starting point or point of leverage with fellow staff or board members to instigate incorporation of performance measures at their own agency. The ARC, who adopted all MAP-21-mandated measures before the legislation passed and has been using additional voluntary measures for many years, finds reviewing best practices at other agencies to be an especially important practice.

Some of the required measures are much more for useful for FHWA in aggregate than they are for many individual MPOs reporting them. Nationally tracking condition and reliability along the NHS system in metropolitan areas can help the USDOT measure national performance of federal infrastructure. However, the classification of NHS at a regional level may not have much meaning. Most regions must look beyond the NHS system if they want to measure performance of main arterials.

The urban-rural divide that KIPDA noted in the differences between state priorities and targets and MPO priorities and targets is also a dichotomy that USDOT had to address when developing the performance measures. As USDOT developed one set of measures

for states, which are often heavily focused on rural infrastructure, and these measures flow down to MPOs, which operate in urban regions, it is not surprising that the MPOs don't see urban needs and goals being addressed as thoroughly as rural ones. The difficulty in providing measures that would be useful to both urban and rural transportation networks may be best solved in developing unique measures for each type of area. Furthermore, the timeframe after states set targets for MPOs to develop different targets is a short window for an agency to complete target development and confer with the board, so regional targets might not appear until later years. Regardless of the specific measures being required, the focus on performance monitoring, reporting, and target setting forces MPOs to begin thinking about performance-based planning, and has pushed at least some agencies to think about what measures beyond the federally mandated ones will be useful in their own context.

All contexts should be considering multi-modal transportation networks, though urban regions are more likely to have a more diverse and evenly distributed mode share. While the Atlanta approach of comparing projects within modal groups allows for more a fine-tuned data-driven prioritization process, it does limit comparison across modes requiring a predetermined division of funds and resources by mode. As many regional, state, and federal goals transcend modes, the intentional connection between metric, measures, performance areas and regional goals in the ARC documentation is an important tool to maintain a multi-modal planning approach.

Beyond incorporating required and voluntary measures in the long-range plans, creating separate documentation focusing on the role of performance measures and the identification of measures and targets has served as a helpful resource for the case study

MPOs. Supplemental plans such as BTPO's Performance Measures Methodology Report, KIPDA's Performance Management Plan, Atlanta's TIP Project Evaluation Framework, and Baltimore's Congestion Management Plan helped each agency establish goals related to the use of performance measures and document their current state of the practice. The documents also clearly identify baseline conditions, specific performance areas, measures, and metrics. Providing these documents to the public demonstrates the agencies' dedication to maintaining and updating them, and provides transparency and accountability beyond performance monitoring by explain methodologies and choices behind what they are choosing to measure.

Incorporating near-term targets required under MAP-21 ties directly into short-term planning, suggesting a natural fit for incorporating performance measures into TIPs. However, the transition to including performance measures in TIP development lags far behind incorporation in long-range plans. Developing performance areas in conjunction with crafting long-term visions and goals for the future is paramount in addressing transparency and accountability with the general public. All the case study agencies identified incorporation of performance-based planning into their TIP as a next step, or are already doing so.

Tying funds to mandates can help agencies allocate resources towards following them. The Atlanta region's redirection of millions of dollars of federal funds due to qualifying as a non-attainment area helped the agency realize the importance of performance monitoring to keep up with federal requirements. The agency board has also seen negative consequences of falling behind federal regulations and are responsive to staff advising action in response to USDOT requirements. MPO boards in Baltimore,

Louisville, and Pocatello did not see the same urgency of fund restrictions from experience, but did not flinch at accepting the new requirements and staff recommendations to work get ahead of DOT requirements by implementing performance measures early on and beyond the required measures.

The agencies discussed in the case studies not only all developed their own voluntary performance measures beyond the federal requirements, but also believed that there is room for requirements in additional areas as well as that there is a need to individual regions and states to think about their own contextual situation and needs. Both Atlanta and Baltimore are MPOs noted the importance that the development of the USDOT required performance measures was influenced by state and regional agency input both before and after the NPRMs were released. AASHTO, state DOTSs, AMPO, NARC, and MPOs all had chances to comment and influence the USDOT to include measures that made sense to them and/or that they were already using. It was also impossible to include everything in the first iteration of performance-based planning rulemaking. Just as federal legislation and regulations regarding performance in the fields of education, health care, and public safety have changed over with improvements stemming from experience and feedback, the same can be expected in the field of transportation. Among areas that staff saw as opportunities for the USDOT to include required measures in the future, the ARC noted a lack of multi-modal measures, BRTB believes accessibility measures should be included, and BTPO sees the inclusion of land use performance measurements as a necessary means to effectively measure and understand congestion. Just as each agency noted to measures and targets in their own plans and documents should constantly evolve and change as current condition, forecasts, and goals change over time, the federal

requirements now have a starting point to grow off of and morph over time with changing conditions as well.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

This chapter includes an overview of the findings of the study, recommendations to regional, state, and federal transportation agencies, study limitations, contributions to the field, and proposed future work. Overall the state of the practice findings from the survey results show a snapshot of how MPOs are developing performance-based planning practices, which can be useful for MPOs to compare themselves to, for state DOTs to assess how to coordinate with their MPOs, and for the federal government to see how the national is responding to MAP-21 requirements. Each element of the study has certain limitations, as does the overall scope of the study. Impacts and contributions include lessons for agencies, framework development, a comprehensive data set to examine state of the practice, analysis of the data set, and identification and dissemination of best practices.

6.1 Findings and Recommendations

MAP-21 is a beginning. Just as the legislation that led into MAP-21 shaped and informed the laws and rules formed in and after 2012, future legislations will build upon the existing laws. Recommendations from experts in research and policy helped to develop current required performance measures, which helped agencies get ahead of the written rulemakings and took into account opinions and needs of various stakeholders. Building upon MAP-21 moving forward should include lessons learned and additional expertise from outside the USDOT. The road-centric requirements in place are likely to expand to include a more multi-modal focus if recommendations from MPOs and experts are listened to. Engaging current efforts in complete streets, transit, bicycle, and pedestrian transportation initiatives can capitalize on existing data and methods to provide

recommendations for the future. Nationally established goals of safety and economic competitiveness tie directly into mode shift away from private vehicles and indicates the need to monitor non-private vehicle activity. Not only is freight movement and efficiency a clear indicator of economic competiveness, but local businesses have been show to make increased profits when there are more people on bicycles and walking passing by them.

6.1.1 Performance Measures Adoption

Most Metropolitan Planning Commissions (MPOs) in the country have a lot of catching up to do to implement data collection and analysis programs needed for performance-based planning. MAP-21 seems to have encouraged the use of the required measures, given the rise in use among agencies in a before and after comparison. Eight of the 12 MPOs collecting all MAP-21 required performance measures only began to do so after MAP-21. MPOs also seem to be pushing the timelines set by the federal government as the adaptation of PM1 measures are much higher than that of PM2 and PM3 which have later deadlines.

A large part of the purpose of the 2012 transportation legislation was tying together transportation planning with performance measurement. Under MAP-21, MPOs "shall develop long-range transportation plans and transportation improvement programs through a performance-driven, outcome-based approach to planning for metropolitan areas of the State" (PL 112-141). While many MPOs stated that they tie together regional goals, objectives, and project prioritization with performance measures, coordination with state plans is lower, and specifically noted among some agencies as an item for improvement when moving ahead setting performance targets. Coordination and data sharing could

create more efficient and streamlined performance-based planning, especially for agencies beginning to use data for the first time ever.

6.1.2 Model Indications

Cluster analyses show that there really are only two different "types" of MPOs no matter what performance-based planning related variables you look at or how you cut the data. The natural grouping of MPOs into just two clusters suggest that there are very few patterns among types of agencies that have adopted more or fewer performance measures. Some groups skew along geographic lines, showing larger, non-southern agencies as more likely to collect voluntary performance measures. Agencies in the Northwest and West as well as agencies collecting freight, bicycle, and pedestrian voluntary measures are grouped together.

There is no magic characteristic or practice at MPOs that indicate their level of use of performance measures. Agencies that collected mandated measures are likely to also collected voluntary measures, and vice versa, but state legislative politics and agency size have only a small impact on whether or not the agency is using MAP-21 required measures, and the population size does appear to be a significant indicator, but has an even smaller effect on the use of voluntary measures. Additionally, reviewing practices at peer agencies (regional, state, or federal), has a positive impact on whether or not an MPO uses voluntary performance measures, but no statistical relationship with the adoption of MAP-21-required measures. Based on the model results, best practices and guidance to help agencies conform to MAP-21 requirements should be based more on the political climate

and policy beliefs that an agency confronts and a little bit on characteristics such as size and geographic location.

Many agencies reported a lack of monetary and personnel resources over a lack of will or understanding as the barriers to collecting and using data in the transportation planning process. Even though agencies citing lack of personnel as a barrier are actually more likely to be collecting more of the required measures, MPOs clearly feel the need for additional resources. A general lack of belief in data-driven processes in transportation planning is a predictor for agencies that are developing voluntary measures in comparison to those that are not, suggesting that the agencies using their own developed measures may be more aware of the internal agency, board, or state opposition to performance-based transportation planning.

6.1.3 Agency Coordination and Lessons

This section includes lessons for agencies at the federal, state, and regional levels to encourage more effective performance-based urban transportation planning. Additional guidance from federal agencies, state agencies, and interest groups can help MPOs move forward in their performance-based planning in transportation. For some measures, given that USDOT has all the data necessary, they could even hire a small team of experts to process all the data, thus relieving all 405 MPOs of the need to process their own data as some MPOs may find this a burden. Additional guidance for data cleaning, consolidation, and processing could also be useful for MPOs instead, as using data at the scale needed for the MAP-21 requirements may be new for many agencies.

With many MPOs looking to peer agencies and State DOTs for guidance in planning strategies such as the use of performance measures, the question of more formal collaborations naturally surfaces. Acknowledgement from state DOTs, who are leading the charge on performance measures and target development based on timelines set by the USDOT, of differences between state context and goals and regional context and goals can help states coordinate with MPOs and support MPO development of unique measures and targets. Incorporating land use measures or context may help agencies see the differences between urban, suburban, and rural needs. Requiring or guiding MPOs to develop documentation specific to performance-based planning may also help them organize their use of performance measures in their transportation planning process.

Whether or not future governance takes the form of former Secretary Foxx's proposed MPO consolidation, a structure that bring together neighboring census-define regions through collaboration, coordination, or megaregion governance would create a formalized avenue for communication and data sharing that could be beneficial to those MPOs currently developing new planning practices on their own.

For agencies already collecting and using the required data, reporting back to FHWA takes added effort. Many agencies were already collecting travel time data, safety data, and even pavement and bridge condition data, but not necessarily processing it according to the USDOT specifications. There are obvious advantages to standardizing data reporting between MPOs to allow for aggregation and national assessments of the data. Meanwhile, some agencies do not have previous experience using any data in their transportation planning and are simply taking USDOT provided data, learning how to process it according to the USDOT requirements, and returning it to the USDOT. MPO staff noted the

importance of streamlining data collection and processing, and noted that some agencies will not have the expertise or tools to clean the data, and their performance reporting will therefore be skewed. One possibility to reduce the effort required by MPOs would be for the USDOT to process all the data, thus removing the intermediate steps between the MPOs and the USDOT.

An increase in transparency with the public is often seen as a positive attribute for public agencies. While usually increased transparency and accountability will improve the public image of an MPO, mismatched priorities can complicate an agency's image. When agency goals don't line up exactly with the goals of the public, this increased visibility can introduce new challenges when the public is skeptical of agency goals. Clearly tying performance measures to stated visions and goals can help the public understand the reasoning behind decisions they may otherwise be skeptical of.

6.2 Limitations

Limitations of this dissertation research include overall study limitations, limitations related to the survey, and limitations related to the case studies. The study timing of survey dissemination and case study interviews and finalization in 2017 was before most of the MAP-21 performance measure rulemakings came into effect. As a benefit to the timing, it was interesting to see how many agencies had still not adopted required measures after USDOT had provided ample information about what would be required including proposed and final rulemakings. It was also useful to talk to the case study agency staff as they were developing their updated long-range transportation plans to incorporate performances measures and targets. However, the early timeframe led to

survey data including few agencies that had adopted all required measures, and some performance areas with very low adoption rates. This makes it hard to model what types of agencies are more likely to have adopted measures in those areas are there are few data points that give information about the types of agencies to do so.

The survey biases as described in chapter 4 section 3 present must be taken into account when looking at survey descriptive statistics and models. Most notably, the unit non-response from staff members or agencies who do not think performance-based planning means that agencies who are less inspired and supportive of performance-based transportation planning might have been less likely to respond to the survey. The item non-response bias of respondents not filling out the question about what voluntary measures they use contributes to a loss of information both of who is collecting voluntary measures and what types of measures they are collecting. Additionally, there were questions not included in the survey in order to keep the survey short and encourage a high response rate. Earlier survey versions that were ultimately not used included dividing the before and after MAP-21 time frame into before the legislation passed, after the legislation passed but before rulemakings were issued, and after rulemakings were issued. This would have provided additional insight to agency adoption timelines and the effects of the legislation versus the regulations.

The staff interviewed for the case studies were aware that our conversations would lead to published work about their agency practices, so their responses may have leaned more positive due to agency loyalty. There were also politically sensitive aspects to some conversations that the staff specifically asked to not be published. Interviewees were also given the opportunity to review the case studies before publication to approve the material.

6.3 Impact and Contributions

This dissertation research contributes to the field of transportation planning, engineering, and policy and analysis of the relationship between national and regional transportation planning in the,

- Development and application of a transferable, customizable framework for the role of performance measures in connection to plans, programs, and available data
- Production of national snapshot of the state-of-the-practice in MPO adoption of MAP-21 performance-based planning requirements
- Identification of relationships between MPO characteristics and practices with the use of performance measures in planning
- Identification and analysis of potential best-practices at MPOs in the use of performance-based transportation planning
- Provision of best-practice examples and agency takeaways and identification of the benefits to dissemination
- Collection of data to inform future federal legislation, rules, or guidance regarding performance-based transportation planning

The research increases the scope of knowledge and understanding on which types of MPOs choose individual mandated and voluntary performance measures; the relationship between federal legislation and changes in transportation planning practices; and how adopted performance measures play a role in the transportation planning process, both generally an in individual cases. Survey responses and case study analyses show the

connection between MAP-21 performance-based planning legislation, USDOT regulations, and MPO planning and project prioritization processes that allocate funding to transportation projects.

Previous studies from public and independent agencies emphasized the importance of MPOs measuring and reporting performance in order to increase accountability and transparency with the public. As public tax dollars fund projects prioritized by MPOs, the public should be able to see how well projects and initiatives perform and to what extent they help achieve regional goals. This dissertation also provides additional accountability to the federal government – who is elected and funded by the public - by examining what effect current transportation legislation and regulations appear to have on regional planning efforts that guide on-the-ground project implementation.

This knowledge is useful for regional and state transportation organizations and agencies to adopt best practices in performance-based transportation planning and set priorities as for what projects to seek funding for and how to best use available funds. Elements of the results are scalable from regional down to local, or up to state or federal levels. Findings show need and desire for DOTs and MPOs to find the right measures and targets to tie into their transportation plans.

The MAP-21 effects on performance-based planning in regional transportation is an example of how federal legislation can affect local practice. Similar efforts in education, public safety, and health have indicated that performance monitoring helps evaluate programming, practice, and improves transparency with the public. This dissertation suggests that regional characteristics are not major indicators of response to federal performance requirements in transportation planning, and possible in other fields as well.

6.4 Future Work

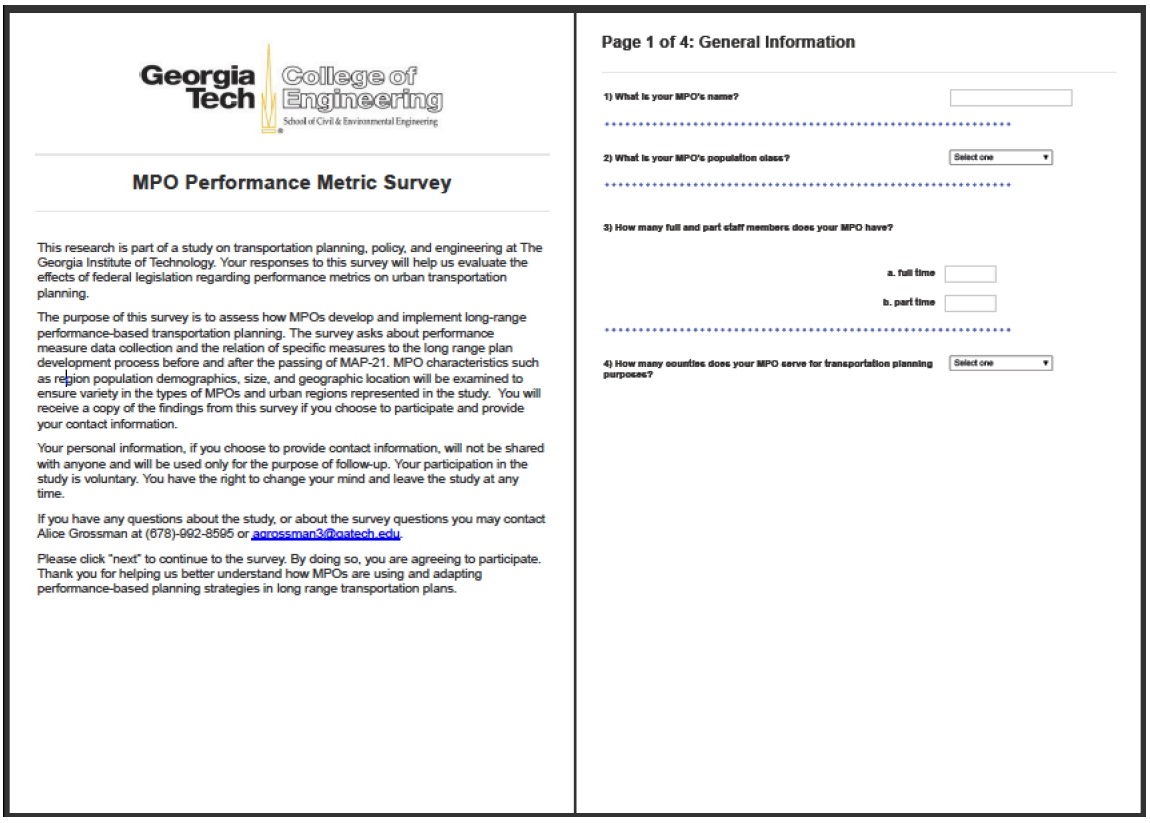
Future work directly building off of this study includes new survey distribution, additional analysis of existing survey data, and additional case studies. Future work building off of this case study could examine performance target setting and meeting in relation to MAP-21 requirements and beyond the requirements; examination of the effects of other aspects of MAP-21 and effects of future federal legislation on regional transportation planning; and further in depth analysis of state reactions to MAP-21 and uses of performance-based planning, including examining the differences between rural areas and urban areas, and the relationships between MPOs and state DOTs.

A future survey to see the use of performance measures at MPOs at the next time point, possibly after all reporting requirements have come into effect, can show the timelines and process that agencies undertook to adopt performance-based planning. Additional data including characteristic variables such as ratios of MPO regional populations and state populations or agency budgets might reveal additional information about how characteristics can predict performance measures use. Further data collection by performance areas such as looking at funding allocations over time in different required and voluntary measures as well as the public engagement process for different performance areas can help to examine nuances in the performance-based planning process and differences between the planning process behind required and voluntary measures.

There is plenty of additional analysis that can be performance on the existing data. Closer examination and modeling of specific performance measures and performance areas, especially including additional variables, could provide greater insight to what types

of agencies are leading in different performance areas. Understanding what variables explain how well an agency is conducting types of performance-based planning can help to identify best practices, such as reviewing practices at peer agencies to inform performance measure use, or characteristic trends such as if MPOs in certain geographic areas underperform and would benefit from additional incentives, guidance, or support. Analysis within clusters also may help identify connections between regional characteristics, other planning practices, and performance-based planning practices.

APPENDIX A. SURVEY INSTURMENT



Georgia Tech College of Engineering
School of Civil & Environmental Engineering

MPO Performance Metric Survey

This research is part of a study on transportation planning, policy, and engineering at The Georgia Institute of Technology. Your responses to this survey will help us evaluate the effects of federal legislation regarding performance metrics on urban transportation planning.

The purpose of this survey is to assess how MPOs develop and implement long-range performance-based transportation planning. The survey asks about performance measure data collection and the relation of specific measures to the long range plan development process before and after the passing of MAP-21. MPO characteristics such as region population demographics, size, and geographic location will be examined to ensure variety in the types of MPOs and urban regions represented in the study. You will receive a copy of the findings from this survey if you choose to participate and provide your contact information.

Your personal information, if you choose to provide contact information, will not be shared with anyone and will be used only for the purpose of follow-up. Your participation in the study is voluntary. You have the right to change your mind and leave the study at any time.

If you have any questions about the study, or about the survey questions you may contact Alice Grossman at (678)-992-8595 or agrossman3@gatech.edu.

Please click "next" to continue to the survey. By doing so, you are agreeing to participate. Thank you for helping us better understand how MPOs are using and adapting performance-based planning strategies in long range transportation plans.

Page 1 of 4: General Information

1) What is your MPO's name?

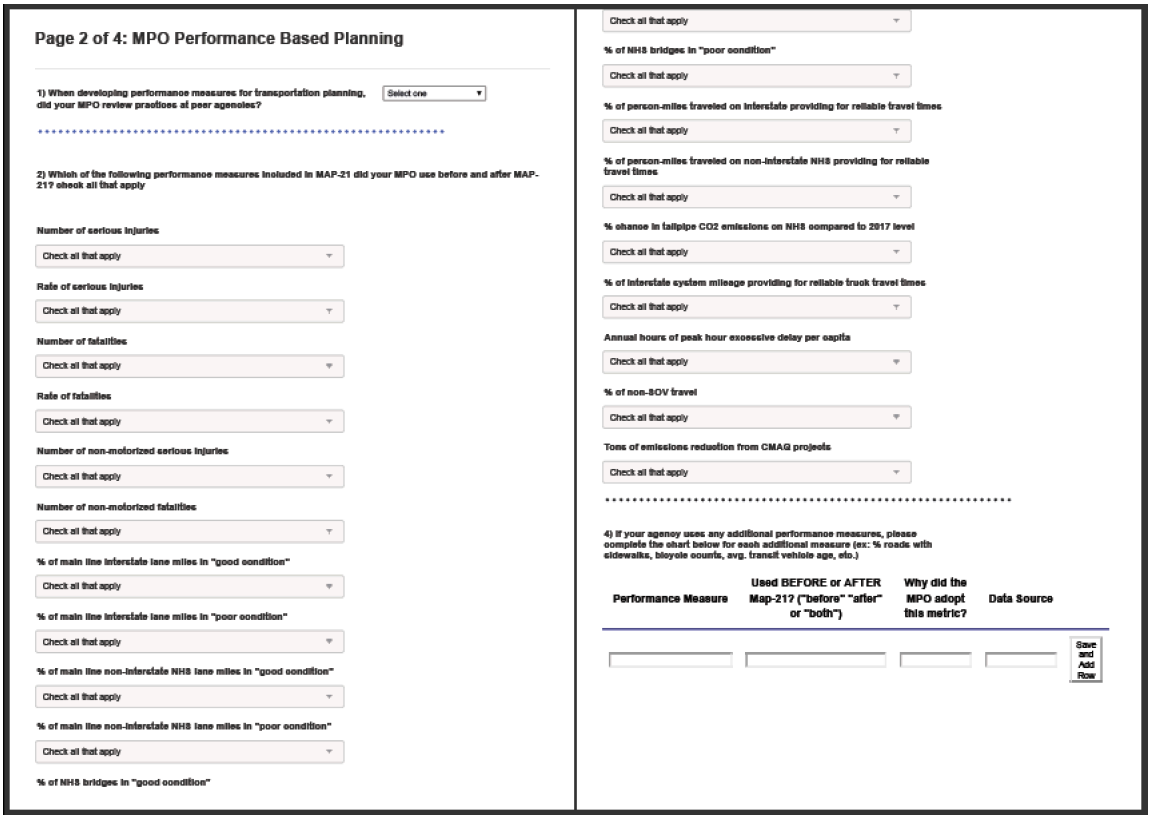
2) What is your MPO's population class? Select one

3) How many full and part staff members does your MPO have?

a. full time

b. part time

4) How many counties does your MPO serve for transportation planning purposes? Select one



Page 2 of 4: MPO Performance Based Planning

1) When developing performance measures for transportation planning, did your MPO review practices at peer agencies? Select one

2) Which of the following performance measures included in MAP-21 did your MPO use before and after MAP-21? check all that apply

Number of serious injuries
Check all that apply

Rate of serious injuries
Check all that apply

Number of fatalities
Check all that apply

Rate of fatalities
Check all that apply

Number of non-motorized serious injuries
Check all that apply

Number of non-motorized fatalities
Check all that apply

% of main line interstate lane miles in "good condition"
Check all that apply

% of main line interstate lane miles in "poor condition"
Check all that apply

% of main line non-interstate NHS lane miles in "good condition"
Check all that apply

% of main line non-interstate NHS lane miles in "poor condition"
Check all that apply

% of NHS bridges in "good condition"
Check all that apply

% of NHS bridges in "poor condition"
Check all that apply

% of person-miles traveled on interstate providing for reliable travel times
Check all that apply

% of person-miles traveled on non-interstate NHS providing for reliable travel times
Check all that apply

% change in tailpipe CO2 emissions on NHS compared to 2017 level
Check all that apply

% of interstate system mileage providing for reliable truck travel times
Check all that apply

Annual hours of peak hour excessive delay per capita
Check all that apply

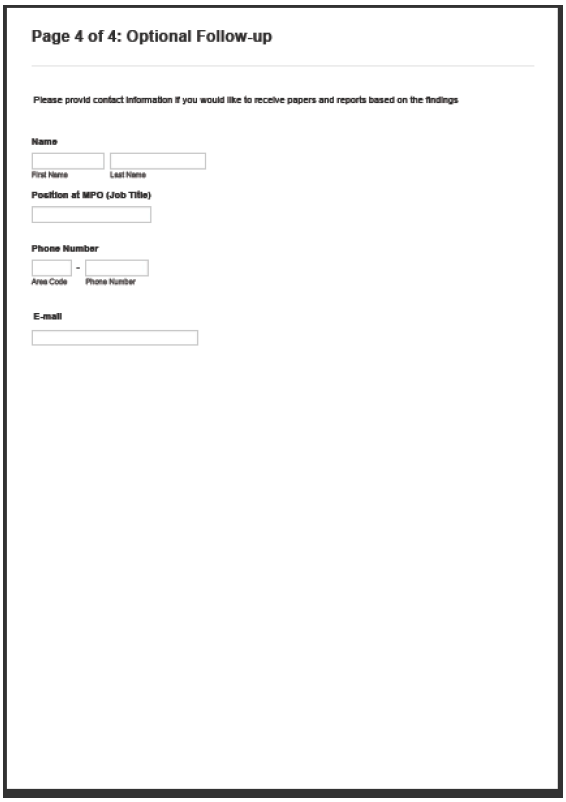
% of non-SOV travel
Check all that apply

Tons of emissions reduction from CMAQ projects
Check all that apply

4) If your agency uses any additional performance measures, please complete the chart below for each additional measure (ex: % roads with sidewalks, bicycle counts, avg. transit vehicle age, etc.)

Performance Measure	Used BEFORE or AFTER Map-21? ("before" "after" or "both")	Why did the MPO adopt this metric?	Data Source

Save and Add Row



Page 4 of 4: Optional Follow-up

Please provid contact information if you would like to receive papers and reports based on the findings

Name

First Name Last Name

Position at MPO (Job Title)

Phone Number

Area Code - Phone Number

E-mail

APPENDIX B. DATA DICTIONARY

Variable Name	Variable Description	Variable Type	Variable Coding	Data Source
MPOName	MPO Name	String	NA	Survey
MPOPop	Regional Population	Categorical	NA	Calculated
MPO_Population	Coded average populations to convert population from categorical variable to numeric variable	Numeric	50,000-99,999 -> 75,000 100,000-199,999 ->150,000 200,000-499,999 ->350,000 500,000-999,999 ->750,000 1 million or more -> 2,000,000	Survey
MPO_Population_Small	Dummy variable to identify small MPOs	Binary	Populations under 200,000 -> 1 Else, 0	Calculated
MPO_Population_Large	Dummy variable to identify large MPOs	Binary	Populations 200,000 or higher -> 1 Else, 0	Calculated
Num_of_Full_Time_Employees	Number of full time employees at MPO	Numeric	NA	Survey
Num_of_Part_Time_Employees	Number of part time employees at MPO	Numeric	NA	Survey
Num_of_Counties	Number of counties under MPO	Numeric	NA	Survey
State_Color	Political party legislative control of the state house	Numeric	-1 for red, 0 for purple, 1 for blue	The National Conference

				of State Legislators
State_Color_Red	Dummy variable indicating Republican party control of the state house	binary	0, 1	The National Conference of State Legislators
State_Color_Blue	Dummy variable indicating Democratic party control of the state house	binary	0, 1	The National Conference of State Legislators
State_Color_Purple	Dummy variable indicating split control of the state house	binary	0, 1	The National Conference of State Legislators
Georgraphic_Region_South	Dummy variable for	binary	0, 1	US Census Bureau
Georgraphic_Region_Midwest	Variable indicating the geographic region in which the MPO is located. MPOs in dtate crossing regional boundaries are counted as being in both	binary	0, 1	US Census Bureau
Georgraphic_Region_Northeast	Variable indicating the geographic region in which the MPO is located. MPOs in dtate crossing regional boundaries are counted as being in both	binary	0, 1	US Census Bureau
Georgraphic_Region_West	Variable indicating the geographic region in which the MPO is located. MPOs in dtate crossing regional boundaries are counted as being in both	binary	0, 1	US Census Bureau

Agencies_did_Peer_Review	Variable indicating the geographic region in which the MPO is located. MPOs in state crossing regional boundaries are counted as being in both	binary	0, 1	Survey
Num_Serious_Injuries	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Number of Serious Injuries"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Rate_Serious_Injuries	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Rate of Serious Injuries"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Num_Fatalities	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Number of fatalities"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Rate_Fatalities	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Rate of fatalities"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey

Num_NonMotorized Serious_Injuries	Variable to tell if and when the agency began using the MAP-21-required performance measure, “Rate of non-motorized serious injuries”	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don’t know, never	Survey
Num_ NonMotorized _Fatalities	Variable to tell if and when the agency began using the MAP-21-required performance measure, “Rate of non-motorized fatalities”	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don’t know, never	Survey
Percent_Mainline_Interstate_Good_Condition	Variable to tell if and when the agency began using the MAP-21-required performance measure, “Percent of Mainline Interstate in Good Condition”	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don’t know, never	Survey
Percent_Mainline_Interstate_Poor_Condition	Variable to tell if and when the agency began using the MAP-21-required performance measure, “Percent of Mainline Interstate in Poor Condition”	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don’t know, never	Survey
Percent_Mainline_NHS _Good_Condition	Variable to tell if and when the agency began using the MAP-21-required performance measure, “Percent of non-interstate	Categorical	Could select any of the following or leave blank: Before only, after only, before and	Survey

	Mainline NHS in Good Condition"		after, I don't know, never	
Percent_Mainline_NHS_Poor_Condition	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Percent of non-interstate Mainline NHS in Poor Condition"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Percent_NHS_Bridges_Good_Condition	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Percent of NHS bridges by deck area in Good Condition"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Percent_NHS_Bridges_Poor_Condition	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Percent of NHS bridges by deck area in Poor Condition"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Percent_Interstate_Reliable_TT	Variable to tell if and when the agency began using the MAP-21-required performance measure, "percent of reliable person-mile travel time traveling on the interstate"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Percent_NHS_Reliable_TT	Variable to tell if and when the agency began using the MAP-21-required performance measure, "percent of	Categorical	Could select any of the following or leave blank: Before only, after only,	Survey

	reliable person-mile travel time traveling on the non-interstate NHS"		before and after, I don't know, never	
Percent_Change_CO2	Variable to tell if and when the agency began using the contended and removed MAP-21-required performance measure, "percent change of CO2 emissions since 2017"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Percent_Interstate_Reliable_Truck_TT	Variable to tell if and when the agency began using the MAP-21-required performance measure, "truck travel time reliability on the interstate"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Annual_Hrs_Delay	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Annual hours of peak hour of excessive delay per capita"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Percent_Non_SOV_Travel	Variable to tell if and when the agency began using the MAP-21-required performance measure, "Percent of non-SOV travel"	Categorical	Could select any of the following or leave blank: Before only, after only, before and after, I don't know, never	Survey
Emissions_Reduction_CMAQ	Variable to tell if and when the agency began using the	Categorical	Could select any of the	Survey

	MAP-21-required performance measure, "Total emission reduction from CMAQ projects"		following or leave blank: Before only, after only, before and after, I don't know, never	
Num_Serious_Injuries	Variable to tell if the agency began using the MAP-21-required performance measure, "Number of Serious Injuries"	Binary	0,1	Survey
Rate_Serious_Injuries	Variable to tell if the agency began using the MAP-21-required performance measure, "Rate of Serious Injuries"	Binary	0,1	Survey
Num_Fatalities	Variable to tell the agency began using the MAP-21-required performance measure, "Number of fatalities"	Binary	0,1	Survey
Rate_Fatalities	Variable to tell if the agency began using the MAP-21-required performance measure, "Rate of fatalities"	Binary	0,1	Survey
Num_NonMotorized Serious_Injuries	Variable to tell if the agency began using the MAP-21-required performance measure, "Rate of non-motorized serious injuries"	Binary	0,1	Survey
Num_ NonMotorized _Fatalities	Variable to tell if the agency began using the MAP-21-required performance measure, "Rate of	Binary	0,1	Survey

	non-motorized fatalities”			
Percent_Mainline_Interstate_Good_Condition	Variable to tell if the agency began using the MAP-21-required performance measure, “Percent of Mainline Interstate in Good Condition”	Binary	0,1	Survey
Percent_Mainline_Interstate_Poor_Condition	Variable to tell if the agency began using the MAP-21-required performance measure, “Percent of Mainline Interstate in Poor Condition”	Binary	0,1	Survey
Percent_Mainline_NHS_Good_Condition	Variable to tell if the agency began using the MAP-21-required performance measure, “Percent of non-interstate Mainline NHS in Good Condition”	Binary	0,1	Survey
Percent_Mainline_NHS_Poor_Condition	Variable to tell if the agency began using the MAP-21-required performance measure, “Percent of non-interstate Mainline NHS in Poor Condition”	Binary	0,1	Survey
Percent_NHS_Bridges_Good_Condition	Variable to tell if the agency began using the MAP-21-required performance measure, “Percent of NHS bridges by deck area in Good Condition”	Binary	0,1	Survey
Percent_NHS_Bridges_Poor_Condition	Variable to tell if the agency began using the MAP-21-required performance	Binary	0,1	Survey

	measure, “Percent of NHS bridges by deck area in Poor Condition”			
Percent_Interstate_Reliable_TT	Variable to tell if the agency began using the MAP-21-required performance measure, “percent of reliable person-mile travel time traveling on the interstate”	Binary	0,1	Survey
Percent_NHS_Reliable_TT	Variable to tell if the agency began using the MAP-21-required performance measure, “percent of reliable person-mile travel time traveling on the non-interstate NHS”	Binary	0,1	Survey
Percent_Change_CO2	Variable to tell if the agency began using the contended and removed MAP-21-required performance measure, “percent change of CO2 emissions since 2017”	Binary	0,1	Survey
Percent_Interstate_Reliable_Truck_TT	Variable to tell if the agency began using the MAP-21-required performance measure, “truck travel time reliability on the interstate”	Binary	0,1	Survey
Annual_Hrs_Delay	Variable to tell if the agency began using the MAP-21-required performance measure, “Annual hours of peak hour of	Binary	0,1	Survey

	excessive delay per capita"			
Percent_Non_SOV_Travel	Variable to tell if the agency began using the MAP-21-required performance measure, "Percent of non-SOV travel"	Binary	0,1	Survey
Emissions_Reduction_CMAQ	Variable to tell if the agency began using the MAP-21-required performance measure, "Total emission reduction from CMAQ projects"	Binary	0,1	Survey
Collected_All_Safety	Indicates whether the agency collected all 6 MAP-21-required safety measures	Binary	0,1	Calculated
Sum_Weighted_MAP21_PMs	Sums the values assigned to each MAP-21 variable accounting for use of measure and timeframe that the measure was collected	Numeric	0=no answer, never, I don't know 1=before only 2=after only 3=both	Calculated
Num_Of_MAP21_PMs_collected	Indicates how many MAP-21-required performance measures the agency collected including all timeframes	Numeric	1 - 19	Calculated
MAP21_PMs_All_Collected	Indicates whether the agency collected all 19 MAP-21-required measures	Binary	0,1	Calculated
Voluntary_PMs_Collected_Binary	Indicates whether the agency specified collecting any voluntary performance measures			Calculated

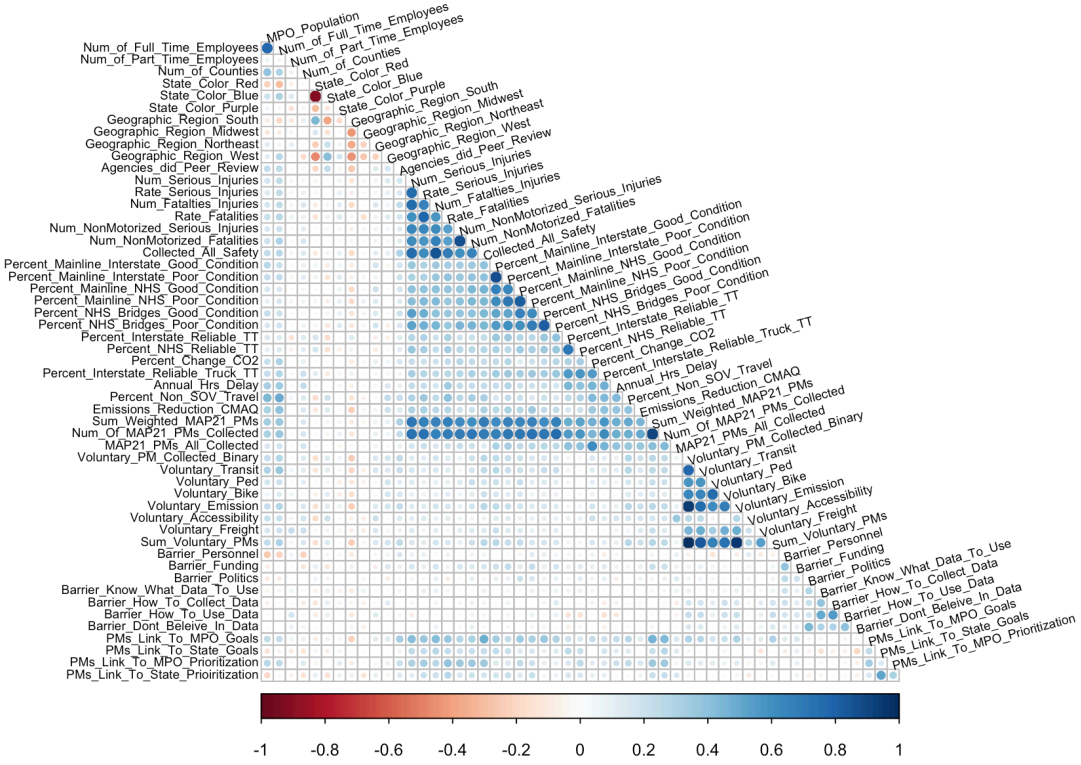
Voluntary_Transit	indicates whether the agency specified collecting any voluntary performance measures relating to transit	Voluntary measures contained variations of the words, “transit," "bus," or "train”		Calculated
Voluntary_Ped	indicates whether the agency specified collecting any voluntary performance measures relating to pedestrians or walking	Voluntary measures contained variations of the words, “ped,” “pedestrian ,” or “walk”		Calculated
Voluntary_Bike	indicates whether the agency specified collecting any voluntary performance measures relating to bicycling	Voluntary measures contained variations of the words, “bike,” or “cycle”		Calculated
Voluntary_Emission	indicates whether the agency specified collecting any voluntary performance measures relating to emissions	Voluntary measures contained variations of the words, “emission," "emit," "pollute," "CO2 ," " VOC," "Nox," "PM2.5”		Calculated
Voluntary_Accessibility	indicates whether the agency specified collecting any voluntary	Voluntary measures contained variations		Calculated

	performance measures relating to accessibility	of the words, "accessibility"		
Voluntary_Freight	indicates whether the agency specified collecting any voluntary performance measures relating to freight	Voluntary measures contained variations of the words,		Calculated
Sum_Voluntary_PMs	Sum of the number of performance areas (transit, ped, bike, emissions, accessibility, freight) used by agency	Numeric	0,1,2,3,4,5,6	Calculated
Barrier_Personnel	indicates whether the agency specified "a lack of personnel" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey
Barrier_Funding	indicates whether the agency specified "a lack of funding" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey
Barrier_Politics	indicates whether the agency specified "a lack of political will" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey
Barrier_Know_What_Data_To_Use	indicates whether the agency specified "unsure what data to collect" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey

Barrier_How_To_Collect_Data	indicates whether the agency specified "unsure how to collect data" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey
Barrier_How_To_Use_Data	indicates whether the agency specified "unsure how to use/analyze" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey
Barrier_Dont_Beleive_In_Data	indicates whether the agency specified "do not believe data-driven approach will improve long-range transportation planning" as a barrier to collecting and utilizing more quantitative data	Binary	0,1	Survey
PMs_Link_To_MPO_Goals	indicates whether the agency specified "measures are linked to MPO goals and objectives" as how the agency uses performance measures in the planning process	Binary	0,1	Survey
PMs_Link_To_MPO_Prioritization	indicates whether the agency specified "measures are linked to MPO prioritization criteria" as how the agency uses performance measures in the planning process	Binary	0,1	Survey
PMs_Link_To_State_Goals	indicates whether the agency specified	Binary	0,1	Survey

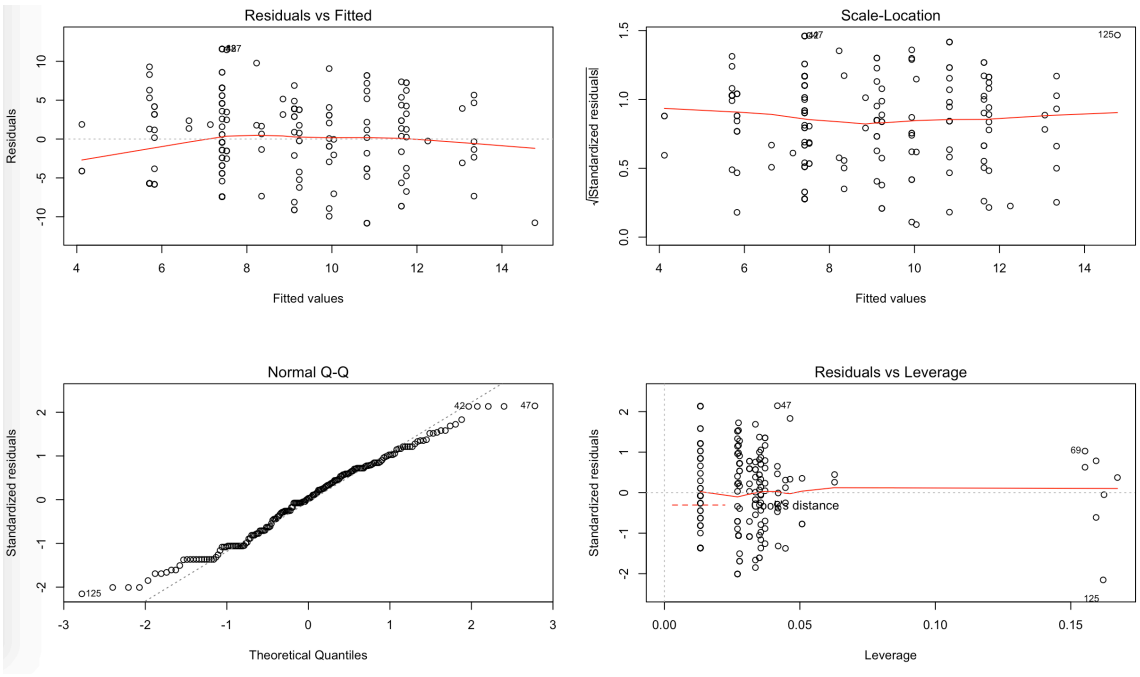
	"measures are linked to state goals and objectives" as how the agency uses performance measures in the planning process			
PMs_Link_To_State_Prioritization	indicates whether the agency specified "measures are linked to state prioritization criteria" as how the agency uses performance measures in the planning process	Binary	0,1	Survey

APPENDIX C. PEARSON CORRELATION MATRIX



APPENDIX D. ALTERNATIVE SUM MAP-21-REQUIRED-VARIABLE LINEAR REGRESSION MODEL AND RESIDUALS

	Num_Of_MAP21_PMs_Collected
MPO_Population_Small	-3.406***
	(0.880)
State_Color_Blue	-1.590*
	(0.952)
State_Color_Purple	1.432
	(2.133)
Voluntary_PM_Collected_Binary	2.519***
	(0.933)
Barrier_Personnel	1.708*
	(0.894)
Constant	9.116***
	(0.910)
N	183
R^2	0.145
Adjusted R^2	0.121
Residual Std. Error	5.465 (df = 177)
F Statistic	6.014*** (df = 5; 177)
Note:	***p < .01; **p < .05; *p < .1


Residuals vs Fitted
Residuals
Fitted values
Scale-Location
√|Standardized residuals|
Fitted values
Normal Q-Q
Standardized residuals
Theoretical Quantiles
Residuals vs Leverage
Standardized residuals
Cook's distance
Leverage

APPENDIX E. ALL VARIABLE CLUSTER ANALYSIS DENDOGRAM

Cluster Dendrogram
ClusterAll.dist
hclust (*, "complete")
Height
0.0
0.5
1.0
1.5
Metropolitan Transportation Commission
Mid-America Regional Council
Birmingham MPO
National Capital Region Transportation Planning Board
Atlanta Regional Commission
New York Metropolitan Transportation Council
North Jersey Transportation Planning Authority (NJTPA)
South Jersey Transportation Planning Organization
Association of Metropolitan Planning Organizations
Hampton Roads Transportation Planning Organization
Richmond Regional Planning District Commission
Roanoke Valley-Alleghany Regional Commission
Chattanooga-Hamilton County/North Georgia Transportation Planning Organization
Knoxville Regional Transportation Planning Organization
Nashville Area MPO
Memphis Area Metropolitan Planning Organization
Northwest Arkansas Regional Planning Commission
Oklahoma City Area Regional Transportation Study
Tulsa Metropolitan Area Planning Agency
Kansas City Area Transportation Authority
Wichita Area Metropolitan Planning Organization
Lawrence Douglas County MPO
Topeka Metropolitan Transportation Planning Organization
Des Moines Area MPO
Omaha-Council Bluffs Metropolitan Area Planning Agency
Lincoln/Lancaster County Planning Department
Sioux City Area Metropolitan Planning Organization
Iowa City Area Metropolitan Planning Organization
Dubuque Area Transportation Study
Quad Cities Metropolitan Planning Commission
Rockford Metropolitan Agency for Planning
Madison Area Transportation Planning Board
Milwaukee Metropolitan Sewerage District
Southeastern Wisconsin Regional Planning Commission
Minneapolis-St. Paul Metropolitan Council
Duluth Area Metropolitan Planning Organization
Fargo-Moorhead Metropolitan Council of Governments
Grand Forks-East Grand Forks Metropolitan Planning Organization
Bismarck-Mandan Metropolitan Planning Organization
Sioux Falls Area Transportation Study
Rapid City Area Metropolitan Planning Organization
Cheyenne Urban Area MPO
Casper Area Metropolitan Planning Organization
Laramie County Transportation Coordinating Committee
Billings Urban Area Transportation Study
Great Falls Area Transportation Study
Missoula Area Transportation Study
Boise Area Transportation Study
Pocatello Area Transportation Study
Idaho Falls Area Transportation Study
Salt Lake City Area Transportation Study
Ogden-Layton Area Transportation Study
Provo Area Transportation Study
Las Vegas Valley Area Transportation Study
Reno-Sparks Area Transportation Study
Carson Area MPO
Truckee Meadows Regional Planning Agency (TRPA)
Flagstaff Area Transportation Study
Yuma Metropolitan Planning Organization
Albuquerque Area Transportation Study
Santa Fe MPO
Farmington MPO
Las Cruces Area Transportation Study
El Paso Area Transportation Study
Midland Odessa Urbanized Area Transportation Study
Abilene Area Metropolitan Planning Organization
Amarillo Area Transportation Study
Lubbock Area Transportation Study
Wichita Falls Area Transportation Study
Texarkana Area Transportation Study
Longview Area Transportation Study
Tyler Area MPO
Beaumont Area Transportation Study
Port Arthur Area Transportation Study
Houston-Galveston Area Council of Governments
Victoria Area Transportation Study
Corpus Christi Area Transportation Study
Brownsville Area Transportation Study
Laredo Area Transportation Study
Waco Area Transportation Study
Killeen-Temple Area Transportation Study
Bryan-College Station Area Transportation Study
Texarkana Area Transportation Study
Shreveport-Bossier City MPO
Lafayette Area Transportation Study
Lake Charles Area Transportation Study
Monroe-West Monroe Area Transportation Study
Alexandria/Pineville Area Transportation Study
Houma-Thibodaux Area Transportation Study
Hattiesburg Area Transportation Study
Gulfport-Biloxi Area Transportation Study
Jackson Area Transportation Study
Meridian Area Transportation Study
Pascagoula Area Transportation Study
Columbus Area Transportation Study
Tuscaloosa Area Transportation Study
Florence-Muscle Shoals Area Transportation Study
Huntsville Area Transportation Study
Gadsden Etowah Area Transportation Study
Anniston-Calhoun Area Transportation Study
Auburn-Opelika Area Transportation Study
Dothan Area Transportation Study
Montgomery Area Transportation Study
Birmingham Area Transportation Study
Florida-Alabama Transportation Planning Organization
Jonesboro Area Transportation Study
Little Rock Area Transportation Study
Fayetteville-Springdale-Rogers Area Transportation Study
Memphis Area Transportation Study
Jackson Area Transportation Study
Gulfport-Biloxi Area Transportation Study
Mobile Area Transportation Study
Pensacola Area Transportation Study
Tallahassee Area Transportation Study
Gainesville Urbanized Area Transportation Study
Ocala Urbanized Area Transportation Study
Orlando Urban Area Transportation Study
Lakeland Area Transportation Study
Tampa Bay Area Regional Transportation Authority
Sarasota-Manatee Area Transportation Study
Fort Myers-Cape Coral Area Transportation Study
Naples Area Transportation Study
Miami Urbanized Area Transportation Study
Palm Beach County Transportation Planning Agency
Treasure Coast Regional Planning Council
Martin County Transportation Planning Organization
Okeechobee County Transportation Planning Organization
Indian River County Transportation Planning Organization
Space Coast Transportation Planning Organization
Volusia County Transportation Planning Organization
Flagler County Transportation Planning Organization
Lake-Sumter Transportation Planning Organization
Ocala-Marion County Transportation Planning Organization
Hernando/Citrus MPO
Hillsborough County MPO
Pasco County MPO
Pinellas County MPO
Polk County Transportation Planning Organization
Charlotte Area Transportation Study
Lee County MPO
Collier County MPO
Sarasota/Manatee Metropolitan Planning Organization
Heartland Regional Transportation Planning Organization
Gainesville Urbanized Area MPO
Ocala/Marion County TPO
Lake-Sumter MPO
Leesburg Area Transportation Study
Volusia County MPO
Palm Coast Urbanized Area MPO
Daytona Beach Urbanized Area MPO
Deltona Urbanized Area MPO
Port St. Lucie Urbanized Area MPO
Sebastian-Vero Beach Urbanized Area MPO
Treasure Coast Regional Planning Council
Martin County MPO
Okeechobee County MPO
Indian River County MPO
St. Lucie County MPO
Space Coast Transportation Planning Organization
Volusia County MPO
Flagler County MPO
Lake-Sumter MPO
Ocala-Marion County TPO

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